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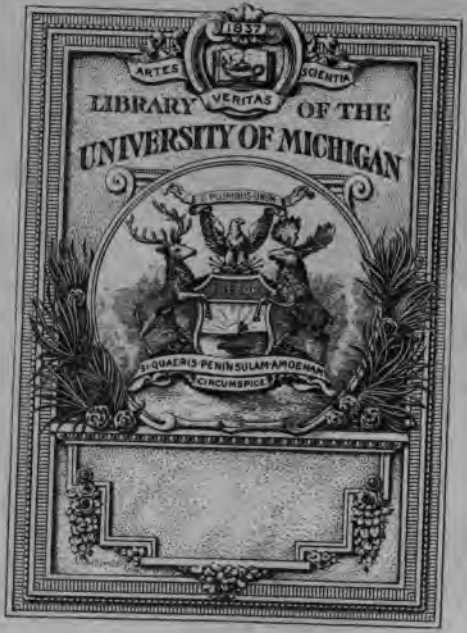
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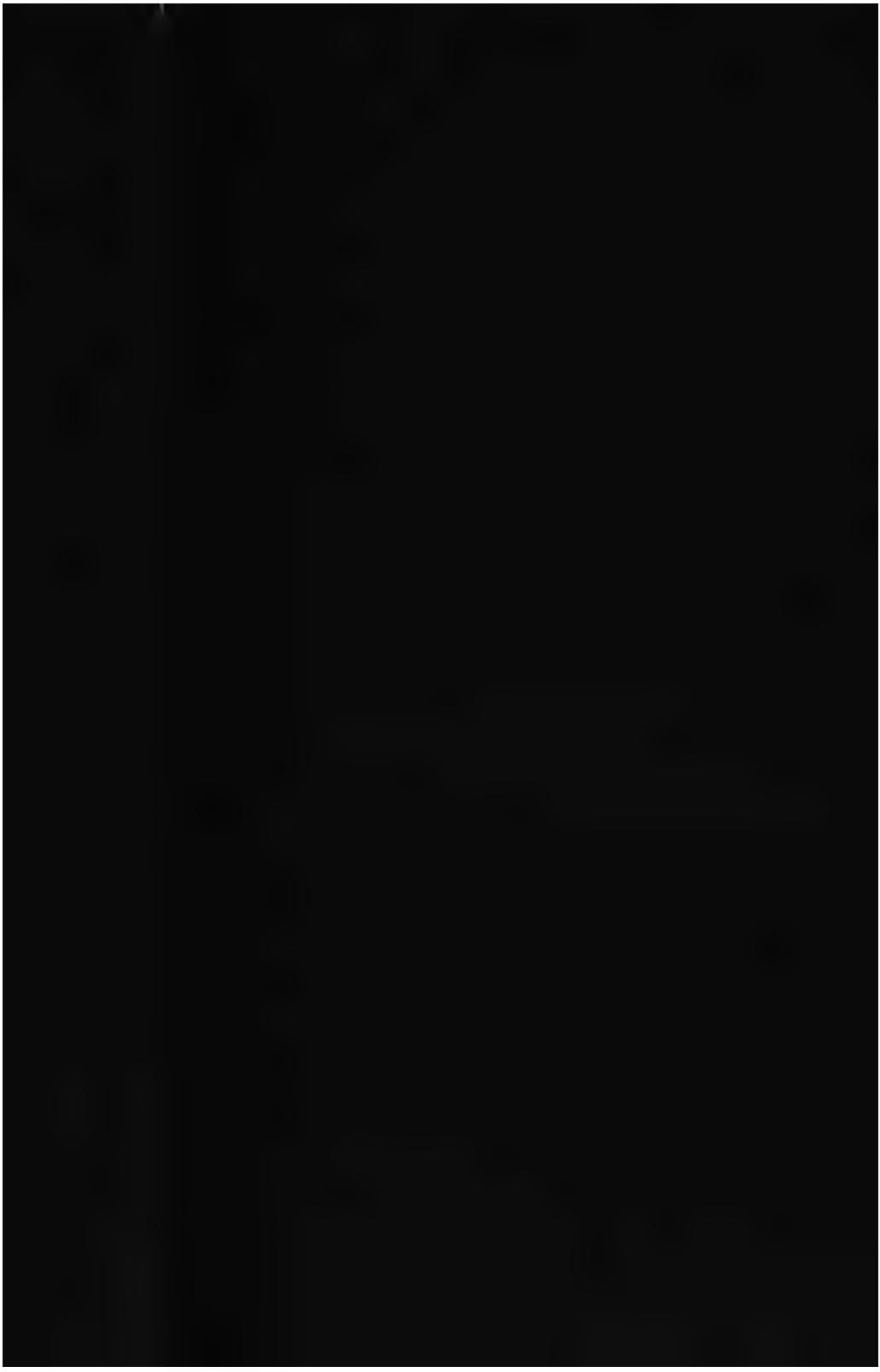

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MDCCCXCVIII.

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1881. Henderson, G. C., M.D., Kingston, Jamaica.
1882. Herring, John F., St. Mary's House, Atherstone, Warwickshire.
1875. Hime, T. W., M.D., 54, Horton Road, Bradford, Yorkshire.
1875. Home, Sir Anthony D., K.C.B., V.C., M.D., Surg.-Gen. (*retired*) 9, Denmark Terrace, Brighton.
1887. Hunt, J. P., Surg.-Major, care of The Admiralty, Whitehall, S.W.
1881. Irwin, Chamney Graves, M.D. (*retired*), Dep.-Surg.-Gen., Casa Hatfield, St. Albans, Herts.
1888. Karkeek, P. Q., Isca, Torquay, Devon.
1887. Kelly, C., M.D., Gratwicke Road, Worthing.
1883. Kirker, Gilbert, R.N., Staff-Surg., M.D., R. N. Hosp., Gosport.
1886. Lingard, A., M.B., Imperial Bacteriologist, Muktesar, Kumâon Hills, N.W.P., India.
1885. Lloyd, W. Harris, M.D., Inspec.-Gen. R.N. (*gone abroad*).
1890. Luard, H. B., Surg.-Capt., Purfleet Rectory.
1881. Lyons, R. T., M.D., Brig.-Surg. (*retired*), Cherry Hinton Hall, near Cambridge.
1860. May, George, M.B., F.R.C.S., 43, Castle Street, Reading, Berks.
1890. M'Neill, R., M.D., Argyll County Council, Oban, N.B.
1881. Oldham, Chas., Brigade-Surg. Ind. Med. Dept. (*retired*), The Lodge, Great Bealings, Woodbridge, Suffolk.
1891. Osborne, Frank, 7, Archway Road, Highgate.
1874. Reid, Walter, M.D., Dep. Inspector-General, Royal Naval Hospital, Haslar.
1863. Rowe, T. Smith, M.D., 1, Union Crescent, Margate.
1881. Russell, E. G., M.B., B.Sc., Surg. Lieut.-Col., I.M.S. Bengal Army.
1859. Sanderson, J. Burdon, M.D., F.R.S., 64, Banbury Road, Oxford.
1884. Simpson, W. J., M.D., King's College, Strand, W.C.
1854. Spinks, C. N., 3, Palmyra Square, Warrington.
1889. Street, A. F., M.D., St. Mildred's Road, Westgate-on-Sea, Kent.
1885. Sturridge, P. F., Stramongate, Kendal, Westmorland.
1894. Tebb, W. Scott, M.D., Boscombe, Bournemouth.
1885. Tomes, Arthur, Surg. Lieut.-Col. Ind. Med. Service, Bengal.
1876. Turner, G., M.D., Cape Town, South Africa.
1879. Watson, Alexander, M.D., R.N., Insp.-Gen., Army and Navy Club.
1893. Whiston, P. H., Surg.-Capt., The Palace, Rochester, Kent.
1854. Wiblin, John, Northleigh, Wimborne, Dorset.

Corresponding Members.

1875. Arkhangelsky, D., M.D., St. Petersburg, Russia.
1856. Barton, E. H., New Orleans, U.S.A.
1853. Beneke, F. W., Marburg, Germany.
1860. Brionde, A. de (*address unknown*).
1894. Catrin, L., Dr., Val-de-Grâce, Paris.

Elected

1851. Cooke, R. T. E. B., The Haven, Esplanade Gardens, Scarborough.
1856. Cox, Wm. Isidore, Hawkesbury-Upton, Chippenham, Gloucestershire.
1871. Cuningham, J. M., M.D., C.S.I., Surg.-Gen. Ind. Med. Dept., Sanitary Commissioner of Govt. of India.
1894. Davidson, Dr., Kevock, 30, Morningside Drive, Edinburgh.
1878. Delmas, Louis H., M.D., P.O. Box 524, Havana, Cuba.
1867. Dickson, E. Dalziel, M.D., Physician to British Embassy, Constantinople.
1895. Gache, Samuel, M.D., Buenos Ayres, Argentine Republic.
1892. Hauser, Philip, M.D., Madrid.
1889. Hewitt, Chas. N., M.D., Red Wing, Minnesota, U.S.A.
1886. Janssens, E., M.D., Inspecteur en Chef d'Hygiène, 1, Rue de Lombard 21, Brussels.
1881. Kynsey, W. R., C.M.G., Colombo, Ceylon.
1857. Leas, Jose Fernandes da Silva, Cape de Verde.
1875. Lent, —, M.D., Cologne.
1886. Le Roi de Méricourt, L., M.D., 5, Rue Cambacères, Paris.
1857. Lowtzoff, —, St. Petersburg, Russia.
1870. Mallet, —, M.D., Warsaw.
1851. Monzon, Rafael, Barbacaos, New Grenada.
1894. Netter, Dr. Arnould, 129, Boulevard St. Germain, Paris.
1854. Purple, S. S., M.D., New York, U.S.A.
1886. Rochard, G., M.D., Paris.
1879. Sarell, Richard, M.D., Pera and Therapia, Constantinople.
1873. Schleisner, —, M.D., Copenhagen.
1874. Schlimmel, —, M.D., Teheran.
1888. Thompson, Ashburton, M.D., Sydney, New South Wales.
1851. Tribes, E., Nismes, France.
1853. Valerj, —, M.D., Rome.
1855. Virchow, Rudolf, Professor, 10, Schellings Strasse, Berlin.
1856. Von Iffland, —, Beaufort, New Quebec.
1861. Whitelaw, Wm., M.D., Kirkintilloch, Dumbartonshire.

JENNER MEDALLIST.

1898. William Henry Power, F.R.S.

TRANSACTIONS

OF

The Epidemiological Society of London.

INAUGURAL ADDRESS OF SESSION 1897–98.

International Sanitary Conferences of the Victorian Era.

By Professor J. LANE NOTTER, M.A., M.D., President.

(*Delivered: November 19th*, 1898.)

Gentlemen,—We are met once again to commence a new session of our Society, and I would express a hope that our meetings this winter will prove as useful and as instructive as those of last year.

It is not necessary to remind you of the many excellent papers we have had read before this Society. Our *Transactions*, which have just been published, indicate the growth and interest taken by the members of the Epidemiological Society—and, indeed, I may add outside it—by men not only belonging to the medical profession but by those who study sanitary science in its many bearings, and who recognise that a knowledge of epidemiology offers even to the non-professional man many features, not only of interest but also of study, if indeed we are to master the rules of life which will allow us to guide and govern an empire on which the sun never sets, and which embraces every diversity of climate and soil.

And, in connection with this subject, it seemed to me that a review of the growth and position of the knowledge of the infective diseases as guiding the methods of prevention taken by the various European States, especially as regards the possible introduction of epidemic disease from the East into Europe, may offer a theme not in itself uninteresting and not unprofitable. It will emphasise the fact that, as regards the knowledge and prevention of the infective diseases which have at one time and another been introduced into Europe, and have decimated many a State there, English views and English methods, which have

been so long and ably advocated by Sir Richard Thorne Thorne, have been gradually—and I may say reluctantly—adopted by the Great Powers; it will also emphasise the fact that England, through all these conferences, has gradually educated Europe to the true principles of self-defence, which have been the means of relieving many a State of the old system of quarantine: a system based upon false principles, adverse to all sanitary improvements, ruinous to trade and to commercial developments, and utterly out of date with modern scientific knowledge.

The proposals and carrying into effect of International regulations for the control of vessels, and so forth, are all embraced within the reign of Her Majesty the Queen, and is one more instance of the progress and development of scientific truths which have taken place during the period of Her eventful reign.

The first suggestion of an International Conference was made by the French Government in 1838, but so diverse were the views held on the subject of quarantine and its enforcement at stations and ports on the Mediterranean, that the proposals fell through owing to various difficulties which arose.

Again, in 1843, the British Government suggested a further conference, but this again was opposed by Austria as premature, as there was no foundation on which to found any regulations which would be acceptable to the Powers.

The wave of cholera epidemics which passed over Europe, and especially in Ireland and other parts of the United Kingdom, in 1849-50, brought the subject again prominently under notice; and accordingly we find the French Government again taking the initiative, and a Conference assembled in Paris in 1851, to consider the question of quarantine in relation to cholera, yellow fever, and plague, the only diseases for which this means of prevention was to be employed. For all practical purposes the results of this Conference were unsatisfactory; there was little unity of opinion, and no system of International control was possible under the circumstances.

It was not until 1865 that the consideration of the question of International control began to be seriously considered. The developments of trade and commerce with the introduction of steam transport, and the inconvenience to which the ship-owners were subject, demanded that some official pronouncement should be made. It rested with the Chief Medical Officer of the Local Government Board to

raise the question; and it was chiefly owing to the masterly exposition of his views, expressed so ably in the Report of the Local Government Board for that year, that the subject assumed the position of scientific enquiry which has ultimately led, step by step, to the almost total abolition of quarantine, not only in England but in countries under International control.

In that Report—the first, I believe, which insisted on the importance of looking to local sanitary conditions as a means of protection offered by strict quarantine—is really the basis on which England has made her stand at all recent Conferences, and with satisfactory results.

"There are", says Sir John Simon, "two kinds of precautions which may be used against quarantine: first, if possible, to prevent the entrance of the contagion; secondly, if the contagion be present, to annihilate as far as possible the circumstances which favour its spread. Subject to one qualification, which is not an important one for the present argument, it may, I think, be accepted as certain that quarantine conducted with extreme rigour, and with the precision of a chemical experiment, will keep cholera out of every part of Europe in which the extremely difficult conditions can be absolutely fulfilled; and thus, if I speak to the dry question of medical practice, I have no hesitation in saying that England ought to resist cholera by quarantine. On the other hand, though I cannot pretend to discuss with any kind of authority the non-medical aspects of the question, it would be mere pedantry for me to ignore that facts which are of common notoriety, and considerations which are of common sense, conflict with that medical conclusion. A quarantine which is ineffective is a mere irrational derangement of commerce, and a quarantine of a kind which ensures success is more easily imagined than realised. Only in proportion as a community lives apart from the great highways and emporia of commerce, or is ready and able to treat its commerce as a subordinate political interest, only in such proportion can quarantine be made effectual for protecting it."

"In proportion as these circumstances are reversed, it becomes impossible to reduce to practice the paper plausibilities of quarantine. The conditions which have to be fulfilled are conditions of natural seclusion, and fulfilment of such conditions by England would involve fundamental changes in the most established habits of the country." Such was the position taken up by the Chief Medical Officer of the Local Government Board, and such are the

principles which guide us of to-day in dealing with this question.

The next International Conference was held in Constantinople in 1866. The conference came to the conclusion that cholera had always its origin in India, and that its extension followed the lines of human intercourse. They were of opinion that quarantine was capable of arresting the disease. Such quarantine should be quarantine of observation or quarantine of rigour. Strict quarantine was to be applied to all ships from an infected port with a foul bill of health, as well as to any vessel which had cases on board during the voyage, although provided with a clean bill. The term fixed was ten days from the time of entering any port, to recommence if any case occurred thereafter. Quarantine of observation was to consist of keeping isolated and under observation for an indefinite time—to be fixed by the local authority—a vessel with crew and passengers, with free ventilation but no disinfection. Strict quarantine was defined as the isolation for a fixed time of a ship and persons on board, with disinfection of all that might contain the germs of disease. The whole of the cargo was to be landed, and the passengers disembarked at a lazaret.

In 1873, so far as cholera was concerned, quarantine was officially abandoned by order of the Local Government Board.

In 1874 an International Sanitary Conference was held at Vienna, the object being to arrange among the Powers interested compulsory regulations, having as their object to bring about a perfect uniformity in the measures to be adopted against the common danger. This conference was the first which, in any form, gave sanction to the principle of medical inspection taking the place of quarantine; and although the decision was not unanimous it obtained the sanction of the majority of the European Powers, and in the case of the minority some important modifications were made. France was the only one of the Great Powers who still adhered to quarantine.

With so large and powerful a minority, however, it was felt that little could be done, and that little had been accomplished. This conference reaffirmed the decision arrived at in Constantinople, that cholera originated in India, that it was transmissible by human agency, and that it might be conveyed from an infected place by means of infected clothing. They unanimously decided that the disease could be conveyed by fluids, especially by water.

In the Fifteenth Report of the Medical Officer to the Local Government Board, Sir R. Thorne Thorne gives us a most admirable history of these conferences, and compares them with the International Sanitary Congress which met in Rome in 1885. He tells us that on no occasion has the value of the adoption of sanitary measures as the principal safeguard against cholera been more prominently recognised than was the case at Rome.

In the matter of disinfection also it was for the first time distinctly laid down that it is not necessary to consider articles as infected merely because they come from a country where cholera prevails; that only persons or articles that have actually been soiled by choleraic discharges, and articles that have been worn by persons suffering from cholera, ought to be subjected to such process; and that in the case of individuals disinfection by means of baths ought alone to be resorted to, fumigation being thus incidentally condemned as useless.

Sir Richard Thorne Thorne adds that in dealing with the action to be taken at ports of arrival, and especially in the Mediterranean, the action of the Conference had a distinctly retrograde tendency. The Vienna Conference, whilst laying down regulations as to quarantine detentions for those countries which preferred to retain the quarantine system, recommended the system of medical inspection for adoption in European ports, this system involving the isolation and detention only of such persons as are found on arrival to be suffering from or suspected of cholera, the healthy being admitted to free *pratique* after certain processes of disinfection have been carried out.

But in the conclusions of the Technical Commission of the Rome Conference, medical inspection finds no place, except in so far as this term may stand for a formality preliminary:—

(1) to a detention of twenty-four hours in cases where the sea voyage from suspected ports has lasted less than ten days; and this not only in cases where cholera, though not then present, has prevailed on board within the previous ten days, but also when no suspicions whatever of cholera exist, either being or having occurred on board; and (2) to the imposition of quarantine detention varying in duration from three to six days on sick and healthy alike.

The next International Sanitary Conference met at Venice in 1892. This conference dealt entirely with the question of cholera. It was convened to consider the

regulations then existing relative to transit in quarantine by the Suez Canal. The delegates were asked to notify what modifications should be introduced into the constitution of the Sanitary Council of Marine and Quarantine of Egypt, and generally the constitution of that council.

As I have already indicated, there has always been a considerable divergence of views by medical authorities and accepted by public opinion in England and in India, and that which prevailed on the Continent, as to the efficacy of quarantine against the contagion of cholera and some other of the infective diseases. The tendency of English opinion throughout this long controversy has been to look to measures of sanitary improvement as the best prophylactic against cholera, and to rely on the application of quarantine for that purpose only to a very small degree; whereas, on the Continent, the belief in quarantine, though apparently diminishing, retains still much of its actual force.

Many propositions were made during this conference, for example: in place of vessels passing through the Canal in quarantine, it was proposed that all ships on which a case of cholera had shown itself within seven days of its arrival at Suez, should disembark at the lazaret not only the patient or patients actually suffering from this disease, but all the passengers and crew who had been in the same portion of the ship; and if a mail or troop-ship, continue its course, without then passing through the Canal in quarantine.

Such a proposal would mean the compulsory landing of healthy persons—passengers and crews—merely because they happened to have been in the same ship as a cholera patient.

The conclusions arrived at by the Venice Conference were subsequently largely modified, and concessions and considerable alterations were made, all of which were favourable to this country. Briefly, the following rules were adopted:—

1. Instead of a prescribed five days' detention of *all* passengers, other than those sick of cholera, at Moses Wells, in the case of vessels without a doctor or a disinfecting stove on board, the detention will vary according to a sliding scale from forty-eight hours to five days.

2. In the case of a vessel carrying a doctor and a disinfecting stove, it is the doctor on board who is to decide what person or persons are to be landed on the ground that they are suffering from cholera. Thus there is a guarantee

against British subjects suffering from dysentery being landed compulsorily.

3. In the same class of vessel, whether mail, transport, or other, all landing of healthy persons at Moses Wells will be avoidable.

If any landing of a limited number of such passengers or crew does take place, it will only occur when it is necessary for the purpose of disinfecting a portion of the vessel. Even then there is an alternative of removal to a vessel moored alongside, and any such removal is for a limited number of hours only, after which the persons in question have the right to return to the vessel. Thus no compulsory landing of any healthy persons can take place.

This conference regarded troop-ships, from the point of view of the transmission of cholera, to constitute a specially dangerous class, owing to the numbers of men on board whose health is debilitated, and who are therefore peculiarly open to any disease that might break out on board. It will thus be seen that the Venice Conference only dealt with the transmission of cholera *by sea* into Europe.

The next Conference was held at Dresden in 1893, to complete, so to speak, the work of the previous conference. It was convened to consider (1) the precautions to be adopted *on land* and at *sea ports* against cholera; and (2) in connection with them the special conditions affecting the Danube are dealt with; also (3) the organisation of the Board of Health at Teheran.

These last two points were apparently not raised or discussed.

The Convention provided a minimum and a maximum precaution. The minimum is obligatory. It corresponds closely with the provisions of the cholera regulations in this country. Practically, the only difference is that the medical supervision of persons landing from an "infected" ship is in this country carried out at the persons' own homes, whereas, under the Convention, such persons are to be detained for a period not exceeding five days from the date of the last case on board.

The practice adopted in England at present is that no person actually suffering from cholera shall be allowed to go about the country, but they do not prevent the circulation of persons who have been in the same ship as the cholera patient, and who may have cholera in the stage of incubation. Should such persons develop cholera, the local sanitary authorities are left to deal with the

disease. Of course, this method can only be adopted in those countries provided with a local sanitary system.

By the Dresden Convention no ship will be detained in any port where there is a hospital for the sick; and all other persons are, if possible, to be disembarked.

The maximum of precautions laid down by the Convention constitutes a limit which no State may exceed. The most important difference between minimum and maximum occurs in the treatment of healthy ships coming from cholera-infected ports: such ships are always to receive immediate *pratique*. As a minimum of precaution, bilge and drinking water must be evacuated, and persons landed from such ships may be subjected to medical supervision at home without any detention.

Healthy ships will not in any case be detained. This is, no doubt, the valuable part of the Convention from the point of view of navigation.

With regard to disinfection also, there is a difference between the minimum and maximum in the case of infected ships; the minimum being that part of the ship actually contaminated shall be disinfected; the maximum that the whole ship may be disinfected. It may be observed that the British Regulations states that "the ship shall be disinfected".

In order to avoid the detention necessary for the disinfection of a ship, etc., even though having cholera on board, the authorities may, under precautions which involve no loss of time, land both passengers and goods. This provision establishes a most important principle, and will be of value to infected ships bound to keep certain dates. The number of such ships is, however, very small.

Under the Convention, all goods are freed from restrictions except fresh rags and things believed to be "contaminated", that is, fouled with cholera matters.

The measures to be applied to land frontiers are analogous to those for sea-ports, with the important exception that only persons actually suffering from cholera may be detained on land frontiers. The fact that greater precautions are to be taken in sea-ports than on land frontiers was mainly due to Dr. Koch's opinion, that risk of infection on board ship is far greater than in a train. If a case of cholera occurred in a train the healthy would leave the carriage at the next station, or would even stop the train, and therefore would be exposed to the risk of infection for a very short time only.

A careful study of this Convention shows that the various

provisions were founded on the tacit belief that the poison of cholera comes exclusively from the evacuations of the sick, and unlike other disease poisons it becomes innocuous if once thoroughly dried.

The conclusions adopted by this Conference embody the principles of notification of cases of cholera, and they aim at preventing certain unreasonable measures of restriction against countries in which cholera has appeared.

Some general regulations were also adopted, such as power to enact special regulations in the case of vessels which carry emigrants, which are overcrowded, or which are in a bad sanitary condition. Some important conclusions as regards merchandise were also agreed to; thus it was decided that goods arriving from sea were to be submitted to no further restrictions, whether prohibiting or relating to such matters as disinfection, than are permissible on land frontiers.

The rules as they now stand may be regarded both as defining a maximum and permitting a minimum of restrictions. As regards vessels deemed to be actually infected with cholera, the maximum restriction to which they may be subjected will involve a detention of the hitherto healthy passengers for a period not exceeding five days, as reckoned from the date of the last occurrence of cholera on board. The minimum of restriction which is held to be obligatory in the case of vessels actually infected agree with the restrictions which it has long been deemed necessary to apply to such vessels arriving in English ports.

This Convention was finally signed by the delegates of Germany, Austria-Hungary, Belgium, France, Great Britain, Italy, Russia, Switzerland, Luxemburg, Montenegro, and the Netherlands. It will last for five years from the date of ratification, and be renewed every five years by tacit consent, unless renounced by one of the high contracting parties six months before the expiration of this term.

Although this Convention does not establish a perfect system it marks an enormous advance; and it must not be forgotten that there were great difficulties to be overcome and many prejudices to combat, which could only be met by concession whenever possible, without sacrificing the broad principles involved.

The next International Conference was convened under the auspices of the French Government, at Paris in 1894, with a view of devising measures for preventing the spread of cholera by way of the Red Sea and the Persian Gulf.

At Venice in 1892, and at Dresden in 1893, sanitary conventions were concluded to the effect that precautions must be taken on the accepted basis that cholera is communicated by human agency and on lines of human intercourse. The Paris Conference really began where the two previous ones left off.

The first point discussed was as to the necessity of requiring a medical inspection of all persons going on board a pilgrim ship before embarkation. The Conference was assured that this was strictly carried out by Great Britain and British India, not only as to cholera but as to all infectious diseases, and the proposal to the requirement was unanimously accepted.

A second proposal related to the disinfection of all articles deemed "contaminées" or "suspect", in accordance with the terms of the Venice Convention; and subject to the understanding that the Medical Officer of Health of the port was to be the judge as to what articles came under these definitions. The proposition was carried.

A third proposal forbidding the embarkation of any passengers deemed to be infected, or suspected of being so, was also unanimously agreed to. We find that the British Delegation opposed the addition of words which would have brought "dysentery" within the scope of the prohibition to embark, because for the purposes of the Indian Empire a complete distinction between dysentery and cholera should be maintained, and the Conference had concern with cholera and not with other diseases. This was accepted by the Conference.

Another proposal was to require an "observation" of five days for pilgrims at the port of departure.

Objections were raised on behalf of India and other British Colonies, and it was decided to grant to each Government the right to act as it saw fit in the matter.

At a full plenary meeting of the Conference decisions on the following heads were arrived at:—

(1) Sanitary police at the ports of departure.

(2) Measures to be adopted on board pilgrim ships.

(3) Sanitary surveillance over pilgrimages in the Red Sea.

(4) Surveillance over the pilgrims going by land to Mecca and Medina.

In this, as in all previous conferences, vessels were classified as follows:—

(*a*) Indemns.

(*b*) Suspects.

(*c*) Infectis.

"Navires indemns" are those ships in which no case of cholera has existed before starting or during the voyage. These receive immediate *pratique* whatever their bill of health.

There remains a recommendation as to maintaining under observation the crews and passengers for five days; but the commencement of this five days reckons from the date when the vessel left the port of departure, and it can only be applied when the port is a contaminated one.

"Navires Suspect" are those in which any case of cholera has arisen within seven days. These receive medical visits, are subjected to disinfection, etc., and there is a recommendation (1) as to maintaining the passengers under observation for five days from the date of leaving the port of departure; and (2) as to prevent the landing of the crew except for purposes of necessity.

"Navires Infectis" are those in which any case of cholera has arisen within seven days before arrival.

The sick and remainder of the passengers are obliged to disembark and to undergo detention under observation for a period of five days at the outside, to date from the occurrence of the last case of cholera. Disinfection of linen is also compulsory.

The Paris Convention was ratified subsequently by the British Government, subject to certain points which bore directly on Indian traffic and pilgrimages from the East.

In 1897 the last International Conference assembled at Venice. This was in connection with the outbreak of plague in the East, and the conference met to settle on an International basis the steps to be taken to prevent, if possible, its spread into Europe.

One of the first points to be dealt with was to settle the incubation period for this disease, and the period to be adopted for administrative purposes. It was admitted that the incubation period was, as a rule, a comparatively short one, namely, of some three or four days. After much discussion, ten days was accepted by a very large majority.

In the discussion which took place on this question, Sir Richard Thorne Thorne urged on the attention of the Conference that, according to all evidence available, plague was much less to be feared in Europe than cholera; and this especially in view of the fact that widespread extention of cholera at times occurred by means of its specific pollution of public water supplies and of rivers, whereas nothing parallel had ever occurred as regards plague. He further remarked on the localised prevalence of plague

when introduced into Astrakhan in 1877, and the widespread European epidemic of cholera which followed the introduction of cholera across the Russian frontier in 1892-95.

The work of the Conference was divided into two sections. One was to undertake the task of formulating rules for preventing the spread of plague *outside* Europe, the other for preventing the spread of plague *in* Europe.

When rules came to be formulated for prevention *outside* Europe, the work was considered under several heads: such as (*a*) the action to be taken on land frontiers; (*b*) at infected ports of departure; (*c*) in the Persian Gulf; and (*d*) in the Red Sea.

The principle of notification was unanimously adopted. Each Government is to notify to other Governments the existence of plague within their several jurisdictions, and at the same time state the measures of prevention which are being carried out to prevent its diffusion. The area deemed to be infected is limited to the actual district or village where the disease prevails, and no locality is deemed to be infected merely because of the importation into it of a few cases of plague which have had no diffusion of the malady.

As regards the precautions to be taken on land frontiers, it was very evident that many delegates adhered to the principle of land quarantine, and were not altogether favourable to the modern system of medical inspection and disinfection. It was finally settled that, during the prevalence of plague, every country had the inherent right to close its land frontiers against traffic.

As regards the Red Sea traffic, the difficulty which had to be overcome was the lengthened period of incubation as regards plague compared with cholera. It was decided, after much discussion, that a healthy vessel may transit the Suez Canal and continue its voyage in the Mediterranean during the period of incubation of the disease, the prevention of which is in question. This decision is a great advance, more so than was ever admitted at previous conferences.

It was also decided that vessels passing through the Canal in quarantine might, subject to the use of the electric light, coal in quarantine at Port Said by night as well as by day, and that passengers might embark in quarantine at that port.

With regard to suspected and infected vessels, the conclusions arrived at are in substance those of the Venice

Convention of 1892, altered so far as these became necessary, in view of the larger incubation period for plague.

Infected vessels, if these carry a doctor and are provided with a disinfecting stove, have the right to traverse the Canal in quarantine, subject only to the landing of those who are suffering from plague, and of such persons who have been in actual contact with the sick or with infected articles, together with the disinfection of the infected compartment of the vessel.

Passing on to the conclusions dealing with regulations to be imposed "in Europe", the following are the chief points to be noted:—

As regards measures to be adopted at ports of arrival, the conclusions of the Dresden Convention were, as far as practicable, adhered to. Healthy vessels, *i.e.*, those on board which, though they have sailed from an infected port, it was decided that they should have at one *free pratique*, but at the option of the local authority certain measures of disinfection of soiled articles may be required.

Suspected vessels, viz., those on board which there has been plague, but no fresh case within twelve days, some limited processes of disinfection, etc., as defined, having been complied with, it is recommended that the crew and passengers should be subject to surveillance for a period of ten days from the date of the arrival of the vessel.

Infected vessels, viz., those on board of which plague is either actually present, or on which that disease has occurred within ten days before arrival. The sick are to be landed and isolated, and the remainder of those on board are to be subjected, at the discretion of the local authority, to "observation", or "surveillance", for a period not exceeding ten days from the date of the occurrence of the last case of plague.

In this Convention the terms "observation" and "surveillance" are for the first time clearly defined; the definition as to the latter stating that, under that system pasgengers are not to be isolated, but are to be allowed at once to proceed to their own homes, where they can remain under medical supervision so long as may be deemed necessary by the local authority.

The interchange of International views at this Venice Conference in 1897, though necessarily somewhat prolonged, may be deemed to have been eminently successful and likely to have far-reaching effects. The results of this last Conference indicate a great advance on the part of

the nationalities represented toward a liberal and truly scientific conception of the means to be adopted by respective Governments for the prevention and control of infective diseases. Previous conferences upon this matter have indicated a wide divergence between the views held and expressed by the British Government and those of other Powers. This last Conference has shown this regrettable divergence of views to be considerably less than it was formerly; in fact, it has demonstrated a well-defined desire on the part of many Continental Governments to accept and come into line, as it were, with the well-known and oft-expressed views and practices of the British in regard to the prevention of epidemic diseases from the East and elsewhere.

Of course, on many minor points and details of sanitary administration, there is still a want of absolute unanimity. This is not altogether to be unexpected in view of the wide differences which exist between different nations, not only in respect of different methods of government, but also in respect of national habits, characteristics, social and economic conditions.

In concluding this review of the results of the last Venice Conference, I desire to state the fact that much of its success was due to the evident desire on the part of all the delegates present to come to such decisions as would be for the benefit and advantage of all people represented.

ON THE

PHYSICAL AND ETHNOLOGICAL CONDITIONS

UNDER WHICH

LEPROSY OCCURS IN CHINA, THE MALAY PENINSULA, THE EAST INDIAN ARCHIPELAGO, AND THE ISLANDS OF THE PACIFIC.

By JAMES CANTLIE, M.B., F.R.C.S.

(*Read: December 17th*, 1897.)

The National Leprosy Fund announced, in the early part of 1894, that a number of 50-guinea prizes would be awarded for the best reports on leprosy in various parts of the world, of which the group of countries above-named formed a section.

It was the appearance of this request for information that caused me to commence this inquiry; and a few of the conclusions I came to after sifting the enormous mass of correspondence on the subject, I now propose to lay before the Society. The method I adopted was to issue a series of questions bearing upon leprosy; soliciting replies from medical men, missionaries, consular agents in countries under British, French, Spanish, Dutch and Portuguese rule, and from officers in the Imperial Maritime Customs Service of China.

The enormous area of the globe comprehended in the inquiry, amounting in all to one-third of the earth's surface, and the immensity of the population, constituting some two-fifths of the human race, concerning which information was expected, seemed a hopeless undertaking, and the more especially as the time given was under twelve months.

At many islands in the Pacific a boat calls once in six months, and, unless the reply was ready in a day or two, another six months before a reply even started on its return journey must intervene. It was impossible in

many instances to ensure the circular reaching its destination in the time allowed, let alone the replies.

For the guidance of future inquirers in this field, it is well at the outset to point out a grievous error. In the schedule I forgot to ask the very necessary question, "Is there any leprosy in the district?" In consequence of this serious omission many sent no reply until a second communication was made, when a letter was received, stating that "I am sorry I cannot help in the inquiry, as there is no leprosy in the district."

Of 383 appealed to, 75 sent in reports; many short, several lengthy, and a few are full reports. All are valuable, all worthy of record; and the concise reply of "No case known", is perhaps the fullest of all.

A copy of the circular issued from Hong Kong to gather knowledge of leprosy in the Far East and the Pacific Islands was sent to the following:

Place.	No. of Circulars sent.	No. of Replies.
China	186	40
Cochin-China	60	3
Corea	23	4
Philippines	3	2
Fiji	7	1
Hawaiian Islands	3	3
Samoa Islands	2	1
Society Islands	2	0
Tonga Islands	1	1
New Hebrides	3	1
Hervey Islands	1	1
New Britain	1	1
New Guinea	2	1
New Caledonia	1	1
Straits Settlements	28	7
Burmah	7	0
Siam	3	2
Java	18	2
Sumatra	19	3
Borneo	13	1
Total	383	75

The most recent work of any magnitude on leprosy is contained in Davidson's excellent book on *Hygiene and Diseases of Warm Climates*. At p. 433 is found the following statement:—"Leprosy exists throughout the whole of the empire of China." If my inquiry has done nothing more than to prove this statement to be false, it will be of considerable value. That the assertion is false is to be gathered by even a casual glance at the text, for it will be read—and read with interest—that not one-third of China is under the ban of leprosy.

Conclusions.

The conclusions arrived at from the study of the evidence brought forward in the following report are—

1. Leprosy is a specific disease, bearing a close analogy, ætiologically and bacteriologically, to tuberculosis, amounting in some points to identity.

2. It is not proven that leprosy is diffused by hereditary transmission, but the evidence is not strong enough to prove that it may not be so distributed.

3. Leprosy may arise in a leprous country independently of personal contagion.

4. Leprosy is to be feared as an inoculable disease, but there is no direct proof that it is such.

5, Vaccination is not believed by any natives of the Far East to be a factor in the spread of leprosy, except in a few cases where the idea has been suggested by Europeans.

6. Inoculation of small-pox is a common practice throughout China, but the geographical distribution of leprosy is totally independent of the frequency of the practice.

7. Leprosy in the Far East is centred in the south-eastern provinces of China—Kwantung and Fokien.

a. Three-fourths of the coolie emigrants from China are from these provinces, and the spread of leprosy in the Malay Peninsula, the Dutch, Spanish and Portuguese, East Indies, and in Oceania, is in all cases coincident and concurrent with the residence of coolies from these provinces.

b. In no instance over this vast area has any native race acquired leprosy, except where Chinese coolies have settled.

c. There seem to be no native names for leprosy in the aboriginal languages, except in Malay, over the area named, though there are loan words.

d. The aborigines ascribe leprosy to the Chinese immigrants, and in several cases the name used shows the belief in the Chinese origin of the disease.

e. Leprosy disappears in some countries with the departure of the Chinese coolie, as in North Borneo.

8. The distribution of leprosy is independent of any geological, geographical, or climatic conditions.

9. Overcrowding, poverty, and bad food, but especially the first, render the individual susceptible to leprosy.

10. The eradication of leprosy is to be effected by improving the hygienic conditions of the centres of leprosy.

11. Leper villages, by which is meant quarters set apart for lepers to find shelter in, but from which they can go at will to beg in the public streets and engage in work, do not show beneficial results as regards the check of the disease.

12. The British Government would be conferring a great service to humanity were a closer inspection of Chinese emigrants travelling by British ships insisted upon. The shipping lines of other countries, especially German, might be invited to co-operate.

13. The British Government, with the co-operation of the French, German, Spanish, Dutch, and Portuguese, the Powers holding the important possessions in the Far East and Oceania, to which Chinese emigrants flock, might effectually check, or at least ameliorate, the spread of leprosy by a monthly inspection of coolies on plantations, in coolie quarters, and wherever Chinese congregate.

14. Deportation, and not segregation, is the proper method of dealing with the Chinese leper in (to him) foreign countries.

15. Segregation of Chinese lepers in an asylum in any country free of leprosy will in time render that country a fresh focus of leprous infection.

16. The great traffic centre of Hong Kong ought to be rigorously dealt with as regards leprosy by the Colonial Government. In the meantime, lepers beg in the streets, live in coolie quarters, and dwell in secluded spots in several parts of the island. In seven years, 1888-95, a minimum calculation shows from 600 to 700 lepers to have been, for the most part unknown to the Government, in the island of Hong Kong.

I shall now proceed to give a brief summary of the evidence by which I have arrived at these conclusions.

China Proper.—The Middle Kingdom.

Of the eighteen provinces which constitute the Middle Kingdom, or the Home Provinces of China, as distinct from the Empire, I received information from thirteen. From the reports I have received, six only of these provinces are known to be leprous.

To understand better the configuration of China, it may be well to give here a brief statement of its geography and geology. The western limit of China (proper) is the vast tableland of high Asia, nowhere sinking below one mile in height, and sending long spurs eastwards, which, though somewhat broken in continuity towards the east, divide the country into three great drainage basins—the Hwang-ho in the north, the Yangtse in the centre, and the Si-kiang in the south.

Eastwards of the highlands, and extending to the coast, is a vast and generally fertile plain—the Great Plain of China—which expands in the valley of the Yangtse in the central province of Hupeh, forming a secondary plain. Hills reach almost or quite to the coast in the provinces from Fokien southwards.

North and west of China lies the vast plateau of Asia, with its colossal ranges stretching east and west, so as to intercept the moisture which might otherwise reach North China.

The result of this configuration of Asia is that hinaC may be divided into two regions: (1) that of the north, or the Hwang-ho region, which is suffering from the secular desiccation of Central Asia, and steadily lapsing into desert; and (2) the southern region, comprising the basins of the Yangtse and Si-kiang, which enjoy the full benefit of the rain-bearing south-west monsoon.

This drying up of the north is inevitable; it is the direct result of the geological growth of the continent, which Skertchly and Kingsmill have shown to be of very recent date. Already the Hwang-ho has lost the drainage of Kashgaria; and the Tarim, once a tributary of the Hwang-ho, is now a continental stream, shut off completely from the sea. The traveller in North China, going west, is vividly impressed with this desiccation. He sees it in dying streams, in dry watercourses, in dwindling or deserted towns; and already the desert seems to be knocking at the western gates of Pekin. Nor is this gradual decay of fertile land entirely owing to secular and therefore irremediable causes; much of it is due to the wilful destruction of trees by the Chinese. China is practically devoid of forests; the Chinaman cuts down every tree as though it were a curse, and his dislike of pastoral life is stripping the land of its grass. Fuel, in spite of the immense coal-fields, is scarce and dear, and the peasantry drag up by the roots every patch of grass they can lay hold of. This is hastening the time when North China will become unin-

habitable. This it is which is driving the people coastwards; this it is which is sending them abroad over all the tropical lands, and much of the temperate. Their own country can no longer support them, and with their utter lack of decency and cleanliness they carry into their new homes not only the thrift of the trader but the filth of the savage. One of the evils of this steady migration is the spread of leprosy. Wherever the Chinese coolie has settled leprosy will be found, and no impartial student of the question can fail to see that in the Pacific and the East Indian islands leprosy has dogged the footsteps of the Chinese coolie. There may be other causes; this is certainly one. The dread disease is independent of soil and elevation—independent of temperature and vegetation; but in the far East it *is* dependent upon the Chinaman.

For the purposes of description, I will proceed to deal with the regions of China apportioned as above by their physical geography.

1. THE NORTHERN REGION.—In the area to the north of the valley of the Yang-tze river leprosy is confined to the province of Shantung. Were the parallel carried beyond the shores of China out into the Pacific, it will be seen that Japan and Korea, lying to the northwards of the line, are both leprous.

Japan is leprous throughout the whole of the southern island, but I can find no proof that the Ainos—the hairy tribe that constitute the original inhabitants of the northern island—are leprous. There are lepers in the northern island, but they are either Japanese or half-castes. Mr. Savage Landor, one of the travellers who have written their observations on the inhabitants of this little-known country, does not mention the Ainos themselves as being leprous.

Korea.—Lepers are met with in Korea only in the southern part. Most of them are Japanese, but occasionally the Koreans themselves are leprous. The number of lepers diminish in direct proportion as one travels northwards; and it may be remarked that it is only in that part of the peninsula, namely, the part situated in the line of route between Japan and Shantung—both leprous countries—that leprosy is met with.

Eastern Siberia.—I cannot pretend to any knowledge of Siberia, save that I visited Vladivostock in June, 1894, and made inquiries concerning leprosy; but no leper was known there. The native population which the Russians

found there has disappeared. The present inhabitants of Vladivostock are Government officials, soldiers and sailors, and a few commercial men from the Baltic provinces of Russia or the shores of the Black Sea. Amongst these specially-selected men leprosy is not likely to be met with.

In Saghalien, again, there are no lepers; doubtless for the same reason, namely, the absence of natives, and the presence only of selected Russians from Europe.

Still more interesting is the fact that the Siberian town of Alexandrovitch, near the mouth of the Amur river, is free from leprosy. Here is a Russian station of some importance,—so important, in fact, that were any lepers living along the lengthy course of the Amur they would have drifted towards the capital for treatment.

Eastern Siberia, then, may be held to be free from leprosy, if the meagre details I have been able to gather from a visit to the region, and the extensive inquiries I have made, are to be relied upon.

Manchuria.—Through this huge tract of territory leprosy is unknown. The ruling family in China are Manchus, and no Manchu is known to be leprous. Dr. Christie, long a resident practitioner in Mougden, the capital of Manchuria, has never seen a Manchu leper.

Chili.—In this province, the most northern of the maritime provinces of China, we have the capital, Peking, and the large city of Tientsin. In no part of this populous and important district is leprosy to be met with. Dr. Dudgeon, who has been in practice in Peking for over a quarter of a century, has never met with a case. This is the more remarkable when it is remembered that within the city walls are communities of all the northern tribes of the empire, Manchus, Tartars, other Mongolian tribes, as well as Chinese from many provinces; still is leprosy unknown amongst them.

A peculiar interest, however, attaches to this part of the inquiry, for, although I have it from the most reliable sources, namely, the local doctors, Drs. Fraser and Irwin, and others (and my own investigations conducted on the spot), that "no leprosy exists in this province", we read that Tientsin has two large leper hospitals. I found this statement in Dr. Newman's prize essay sent in to the National Leprosy Fund. Dr. Newman does not quote it on his own authority, but on that of Dr. Doolittle. At page 81 of the Report referred to, Doolittle is credited with the following:—

"There are two large asylums, or places of refuge and of residence, at *Tientsin*, for the wretches who are taken with leprosy, located on the outside of the city near the east and west gates. Two or three hundred lepers live at each of these asylums."

A long report of this asylum is given.

I may say at once this is a mistake: there are no leper hospitals at Tientsin. My reasons for stating this so positively are as follows:—

1. I personally visited Tientsin in 1894, and made extensive inquiries as to the prevalence of lepers and leper hospitals. I found neither the one nor the other.

2. The positive written statement of resident medical men, English and Chinese, well acquainted with Tientsin, that no leper hospital exists there.

3. As I was not acquainted with Doolittle's statement not having seen Dr. Newman's report until after my arrival in this country, I wrote Dr. Irwin, of Tientsin, to make further inquiries as to the presence of leper hospitals at Tientsin, and asked him to telegraph his reply. He sent in reply to my query, "Are there any leper hospitals at Tientsin"? "No". From all these cogent proofs I conclude that the statement that leper hospitals exist at Tientsin is a misrepresentation or a misstatement, and that Chihli is free from leprosy.

Shantung.—The only province of Northern China in which leprosy is met with constitutes the bold peninsula which juts out seaward towards Japan and Korea. Dr. Watson, who has sojourned in the interior of Shantung for many years, states:—

"Every village of any size—and they are very numerous—has its one or two lepers, who are regarded as outcasts by the natives, and compelled to dwell apart."

One might immediately jump at the conclusion that Shantung was infected from Japan or Korea; but if that were the explanation, leprosy would in all probability be be met with most frequently on the Shantung littoral. Such, however, is not the case, for Dr. Watson expressly states that it is in the interior that leprosy prevails, and I could find no cases of the disease at Chefoo, a town on the seaboard. Cases of leprosy do occur occasionally in Chefoo, as I am aware from the testimony of Dr. von Tunzelman the resident practitioner there.

Ho-nan.—Concerning this province I have no information. As it borders upon Shantung it may be leprous, but between the two provinces the huge barrier formed by the Sacred Mountains intervenes.

Shen-si, Shan-si and Kan-suh.—Of none of these provinces have I any information. Were leprosy rife in any of them, however, Peking would would be sure to be invaded by the lepers, whence they would drift, either for the purposes of begging or for advice from the native or European doctors congregated in the capital. In the whole, therefore, of the vast region of China to the north of the Yang-tze valley we have evidence, and frequently positive knowledge, that leprosy, except in the province of Shantung, is unknown.

II. THE CENTRAL REGION.—The eight provinces included in this group constitute the gathering-ground of the mighty river Yangtze-kiang. Arising in the mountains of Thibet, the river pursues its course for three thousand miles to the Yellow Sea. The magnitude of the stream may be imagined when at Ichang, some 1,200 miles from the sea, steamers can find their way thither. In this region leprosy is but little known. At the three great centres, Shanghai, Hankow and Ichang, leprosy is only met with but at one—Hankow. Above Ichang, in the far remote province of Szechuen, where the Yangtze begins to shape its course, leprosy is met with, although in anything but a severe form.

Sze-chuen.—Drs. Davenport and Finch reporting, the one from Chung-king, the other from Sui-fu, both pronounce "leprosy to be rare".

Kwei-chow.—From this little-known district I have no information.

Hoo-peh and Hoo-nan.—These provinces, the one to the north the other to the south of the Yang-tze, have Hankow as a centre. As Hankow is an infected region to some slight extent, it is fair to assume that they are both leprous. But Hankow is not markedly leprous. Drs. Hodge and Morley, writing from thence, state: "Leprosy is no great scourge in or around Hankow".

Kiang-si, Ngan-whei, Che-kiang and Kiang-su, the provinces bordering on the lower reaches of the river, are known to be well-nigh, if not wholly, free from leprosy. This may be gathered without further evidence than that Shanghai, the great centre of trade at the mouth of the Yangtze, is not even visited by lepers. The following statements by two well-known authorities will bear out this assertion. The late Dr. Jamieson wrote, May 1894:—

"I should be very glad to answer your questions respecting leprosy, if there were any specimens of the disease to be found here. It is the very rarest of rarities in Shanghai: so rare that I should be afraid to

say how few cases I have seen in the twenty-six years during which I have been, without interruption, connected with large hospitals for natives."

Letter from Dr. Burge, Shanghai, May 22nd, 1894:—

"I am sorry I have very little experience as regards leprosy. I will, however, see if I can collect a little information on the matter."

Dr. Burge's statement bears out Dr. Jamieson's. It is evident that leprosy had not been seen in Shanghai by either of the observers, so that it may be conclusively stated that leprosy is not indigenous to the province of Kiang-su.

A study of the areas where leprosy is met with, and where absent, along the course of the Yang-tze, will show that leprosy does not follow the course of the river. It is met with, though rare, at Sze-chuen, some 2,000 miles up; it is not known at Ichang, 800 miles below. It is met with again at Hankow, some 600 miles below Ichang, but throughout the last six hundred miles of the Yang-tze it again disappears.

Leprosy is not rife in any part of the central region, and in the majority of the provinces bordering on the Yang-tze it is unknown.

III. THE SOUTHERN REGION.—Included in this group are the four provinces of Yun-nan, Kwang-si, Kwangtung, and Fokien. Here a very different state of matters prevail, for it is the home of leprosy in China, and the last two provinces named are perhaps the most highly leprous spots on earth. The Chinese style Kwangtung the "cradle of leprosy".

It is needless to give here in detail the enormous mass of evidence contributed by careful observers in these districts. It all too surely proves how terrible a scourge leprosy is in these southern provinces.

Here are the great ports of Canton, Hongkong, and Swatow, whence coolies depart in tens of thousands to all parts of the Archipelago: to Indo-China, the Straits Settlements, Java, Sumatra, the Philippines, Borneo, and many of the Islands. Leper retreats abound throughout the country, and the leper is to be found in every village, every street, on every river, and on every public highway. Attached to all towns of any size, one finds "leper villages": a sure sign that the neighbourhood is leprous.

Hainan.—The island of Hainan, off the south coast of Kwangtung, is inhabited by Chinese only along part of the coast. The centre of the island is occupied by aborigines,

who never mix with the Chinese by marriage, and amongst these people leprosy is unknown.

Formosa.—Formerly a part of the Chinese province of Fokien. Formosa now belongs to the Empire of Japan.

The inhabitants belong to two races, the Chinese and the aboriginal Igorotes. The Chinese are settled on the low lands, where they have been for centuries; while the mountains and the east coast still remain to the Aborigines, who live in deadly feud with the Chinese.

Dr. Angear, writing from Tamsui, Formosa, says :—

"Leprosy does exist with us amongst the natives (Chinese), who reside along the coast. Among the Pe-pe Hoans (civilised aborigines), leprosy is not known to exist. The Cheng-Fan (savage aborigines) are also believed to be non-leprous."

INDO-CHINA OR COCHIN-CHINA.

The French Provinces of Indo-Chiné comprehend the old states of Tonkin, Annam, Cochin-China, and Cambodia. In fact, Cochin-China is commonly the name given to the region. It consists of the large rounded peninsula bulging out into the China Sea, having China to the north, the Malay Peninsula to the south, and Burmah and Siam to the westward.

The inhabitants of the northern regions, Tonkin and Annam, belong to the Giao-shan group of the Mongolic stock, and (especially the Annamese) are distinctly lower in culture than the Chinese. In Cambodia we come across a very curious race, forming several tribes, of distinctly Caucasic type.

It is a southern projection of China from the Thibetan plateau, and through it flows the grand river Mekong.

The climate is tropical, and much of the country is covered with dense jungle.

The climate, soil, crops, and natural features are similar to those met with in the Kwangtung province.

The population consists of :—

Annamese	1,710,000
Cambodians	110,000
Chinese	65,000
Champas and Malays	10,000
Hill-men and others	10,000

Amongst the Annamese, leprosy is as prevalent as it is amongst the Chinese in the province of Kwangtung. Segregation is extensively—and, in some instances, rigorously—practised.

SIAM.

Siam forms the greater part of the obtuse peninsula between Tonkin and Burmah. It is physically an extension of the southern part of the high plateau of Eastern Asia, where it breaks up into a remarkable series of parallel mountain ranges, each with its own river.

Geologically, the country is like the Malay peninsula; climatologically, it is like the interior of South China, and is distinctly continental.

The Siamese proper belong to the Mongolic stock, but there are said to be tribes of Indonesian origin in the interior, of whom little is known.

In Siam, leprosy prevails to an extent which in a European country would be considered alarming. Every hamlet has its leper, and every village and town has its leper quarter. This is the information supplied by Dr. Cheek, who for ten years took careful notes in connection with this subject, whilst travelling throughout the length and breadth of Siam.

Leprosy, although rife in parts of the country, affects the Chinese more than the Siamese themselves. Although there are no leper establishments in Southern Siam to be seen, a large village about 30 miles from Bankok gives shelter to most of the beggars about the capital.

C. MALAY PENINSULA.—STRAITS SETTLEMENTS.

The Malay Peninsula, of which the Straits Settlements form the southern portion, comes within that remarkable zone of equable temperature which lies about the equator.

Running down the peninsula, and forming a broken backbone to it, is a mountain system, and as a rule the country is rugged, save for the alluvial stretches which border the numerous rivers and *sungeis*, or brooks. The rocks are chiefly granite and archæan, with overlying sandstones, etc., of Tertiary age in places. Civilised life is one uninterrupted struggle against the vegetable world. Plant life is so vigorous and rapid, that a year or two of neglect serves to reduce cultivated land into secondary, but very dense jungle.

The ethnology is interesting; for we have here to deal with quite different stocks from those of China. The wild tribes may be divided into the *Orang Benua*, that is, men of the country, who are primitive Malays, and the *Jacuns*, or *Sakais*, a Negrito people inhabiting the fastnesses of the

interior. The civilised Malays occupy the coast and all the important towns and villages, which of course are their own erections. In the ports, large numbers of Chinese, chiefly from Kwangtung and Fokien, have settled as traders, some of whom are very wealthy. Other Chinese are marching inland wherever planting is making progress, and this labouring or coolie class forms quite a large section of the community in such localities. With them, generally as a somewhat higher class of plantation hands, numbers of Japanese are to be found; and there is a constant influx and efflux of these Japanese and Chinese coolies. In the trading centres, such as Singapore, Penang, and Malacca, many of the stores are kept by Tamils, Klings, and other natives of India.

In dealing with the Straits we must always bear in mind this predominance of Chinese over native races. We must also bear in mind that this is not a permanent population. The Chinaman's one idea is to amass wealth enough to return to China; hence there is an enormous influx of fresh Chinese blood constantly going on, and with it an equally great and constant chance of introducing disease.

The Malays are subject to leprosy; there is as much evidence of its presence amongst them as amongst the Southern Chinese. Leper villages and unwritten social rules testify to the scourge, and all the natives, however secluded, know of the disease, which they call *kosta*.

Singapore is the headquarters of the British Government of the Straits. Here a large and well-appointed leper hospital affords refuge to many patients, chiefly Chinese; but a number of Malays, a few Portuguese, and occasionally a European, are met with amongst its inmates.

Penang is in much the same position as Singapore as regards leprosy. In the words of Dr. Kerr: "so far as Penang is concerned, few cases of leprosy arise here; though we have a large leper asylum the cases are imported from other countries, principally China". That leprosy is endemic on the island may be denied by even an unprejudiced authority.

Perak.—In this state the Malay is being gradually ousted by the Chinese, who already form half the population. As usual, the Chinese are chiefly from the provinces of Kwangtung and Fokien, Swatow and Amoy sending the chief number of emigrants.

Dr. Fox does not lay the introduction of leprosy at the door of the Chinese, yet these people are more frequently the

subject of leprosy than the Malays, as shown by the Singapore and Penang asylums.

In Perak we meet with aboriginal tribes, still in a state of savagery, who, through timidity or disdain, keep aloof from the intruders, be they Malay or Chinese. Their numbers are few (5,700 in Perak), and there is no evidence that they have leprosy amongst them.

Muar.—In this state leprosy is common. The Chinese suffer for the most part, Malays rarely. It is from this State the vaunted cure for leprosy, gurjun oil, is obtained.

Sungei Ujong.—From this State the report is confirmatory of the general statement that may be drawn from a perusal of these valuable communications from the peninsula.

The Chinese form more than half of the population, and it is *chiefly among them that leprosy is found; indeed, the Malays in Sungei Ujong are quite free from it.* The Sakais, or aborigines, are not reported upon by Dr. W. L. Braddon.

Johor.—Dr. Wilson, writing from Johor Bahru, the capital of the kingdom which separates the Straits from Singapore island, conveys the information in his letter that the Chinese are again the offenders. Out of thirty cases three were affected before landing, and the remaining twenty-seven developed the disease in the district.

The evidence from the Straits Settlements strengthens the opinion that forces itself upon one ever since this inquiry began, namely, that the Chinese are the carriers of leprosy; but the information is not exhaustive enough to warrant more than a cautious suggestion to that effect, as far as the Malays are concerned. Still, it is very remarkable that even in Malaya itself it is the Chinese who are the greatest sufferers; and as not one of these Chinese in a hundred is born in Malaya, and few remain many years, and as we know that leprosy is happily very slow of incubation, it certainly does seem more and more likely that leprosy is being constantly brought in afresh from infected Kwangtung and Fokien.

The information received from the Malay peninsula justifies us in drawing the following conclusions:—

1. In the Straits Settlements leprosy is rife.

2. Three leper hospitals have been found necessary, viz., Singapore, Penang, and Johor Bahru.

3. The peninsula is inhabited by Malays, Chinese, Japanese, Indians, and aboriginal tribes.

4. In the places reported upon the Chinese population equals or exceeds the native Malay race.

5. Chinese are the chief sufferers from leprosy.

6. Chinese form the largest number of the leper patients in all the hospitals.

7. Some Chinamen were lepers on landing, bnt the majority developed the disease during a residence in the Settlements.

8. Jakuns, or Sakais, the only aboriginal race reputed leprous, are *reported* to have leprosy amongst them to such an extent that they have adopted compulsory segregation. No Jakun, however, has been *seen* by any of the contributors to have actual leprosy on him.

9. Gurjun oil is produced in the Muar district of Johor, but is not, at all events, a prophylactic against leprosy.

10. Whilst inclined to lay the presence of leprosy in the Straits at the door of the Kwangtung and Fokien immigrants, the facts will scarcely justify the conclusion.

11. Whether imported recently or not, leprosy is now endemic in the Straits Settlements.

12. Vaccination is not accused in any place by any people as a contributor to the spread of leprosy.

East Indian Netherlands.

Sumatra.—This great island, 1,070 miles in length, is bisected by the equator, and therefore comes within the equatorial region climate.

The inhabitants consist of Malays, and several Indonesian tribes which belong to a pre-Malayan period. The Malays occupy most of the area, and have from time immemorial had permanent settlements in the districts of Menangkabau and Palembang, and from this centre a large proportion of the Malay migration has started.

The Indonesian tribes, the true aborigines, include the Battak of the north, the Kubus of Central and the Passumahs of South Sumatra.

Dr. Graham, F.R.C.S., Lankat Deli, reports that:—

"Leprosy is met with almost exclusively amongst the Chinese; one European contracted the disease in Lankat seven years ago; two cases of leprosy only have I seen amongst the Bandgerese, and three amongst the Bengalis."

Java.—The natives belong exclusively to the Malay race, and here attain a high degree of culture, chiefly under Hindu influence.

Leprosy is reported to be rare. The Chinese are mostly affected.

Of the four existing hospitals, one is for lepers of all nationalities, but how the numbers are distributed is not stated. The other three are significantly stated to be for Chinese natives, and one of these is supported by the Chinese.

Segregation was practised up to 1865, when the Government rescinded the regulations. There were fourteen hospitals up to 1865, eight were then gradually abolished, six still existed in 1886, serving as voluntary asylums for lepers. In 1883 there were only 189 inmates, all told.

Mr. Powell goes so far as to write that "leprosy is met with everywhere, only it is said to be imported by the Chinese; it seems to have been unknown before the arrival of the Chinese in Java". This, no doubt, should be taken as meaning "since Chinese coolies began to arrive."

Moluccas.—Of all the possessions belonging to the Dutch, the Moluccas are the most leprous. No doubt this arises from the fact that they are the oldest of the European holdings in this region.

In *North Celebes* and *Sunda Islands* leprosy is not known. These islands, in fact, are out of the way of ocean traffic, and the natives not having come in contact with the Chinese are free from the disease.

The trend of belief in the Dutch possessions evidently is that the Chinese coolie brought leprosy.

Leprosy in the Pacific.

The extent of this vast ocean, the multitude of islands which lie scattered on its surface, and the impossibility of obtaining reliable information, renders the task of an inquiry into the prevalence of leprosy amongst the inhabitants in these far-off isles an Herculean labour.

Imperfect, however, as the knowledge I have been able to collect may be, it is not likely that any great centre of leprosy in the Pacific has been missed. Practically, there are three homes of leprosy in the Pacific—Hawaii, Fiji, and New Caledonia. At once the thought strikes one, Hawaii is practically American, Fiji is British, New Caledonia is French. Yet the Americans, the British, and the French are not leprous, and cannot have introduced the disease. Leprosy is not indigenous in any part of the Pacific, yet there must be some common factor in the three centres which has determined its presence. That factor—indeed,

the only common factor—is the Chinaman, and he *is* leprous.

How Hawaii become leprous is a question often discussed, but there seems no evidence that the islands contained lepers until the year 1848, when the gold rush to California attracted men from all parts.

If, now, we turn to the records, we shall see that it was exactly at this period when leprosy is said to have appeared; it is 1850 that the Board of Health is established, and nothing said about leprosy; and it is not till 1863 that Dr. Hillebrand reports on "the rapid spread of that new disease, called by the natives 'Mai Pake'". In 1864, it is reported by the President of the Board of Health as spreading to other islands; and from this time on the story of Hawaii, and of its leper settlement at Molokai, is known to all.

Fiji.

The Fiji group contains about a hundred islands, nearly all lofty and fertile, and, like all oceanic islands, are of volcanic origin.

Fiji is the border-land between the light and dark coloured Polynesian races, the former probably of Malay, the latter of Negro origin.

Leprosy is well known in Fiji, but both Drs. J. M. Barnes and J. F. Pound report "It is rather rare".

It would seem, indeed, that the Chinese coolies are unknown at the present moment in Fiji; but in earlier days they travelled thither, and the disease seems to be recently introduced, for there is not a particle of proof that leprosy was known here until well into the present century.

Borneo.

The true natives may be classed under two headings, Dyaks and Buludupies. The Dyaks are generally classed as a branch of the Malay stock, but long and intimate intercourse with them has forced Skertchly to consider them as belonging to the Indonesians. The Buludupies of North Borneo are as certainly neither of Dyak nor Malay origin. They belong possibly to that curious relic of the Caucasian race which has left another outlier in Cambodia. The Malays are not indigines, and only occupy the littoral.

In 1888 there were no lepers in North Borneo, but several cases among Chinese occurred within two or three years, when a great number of coolies from Kwangtung

and Fokien were brought into the country for the newly-opened tobacco estates. They came in hundreds by every ship, and soon a large contingent were shipped from Singapore, and latterly a number of Javanese from the tobacco estates of Sumatra.

In 1890, the first case of leprosy was noticed, and in this year the Government set apart an old kajang (palm-mat) hospital or shed for the reception of lepers on the island of Bahalla, near Sandakan. There were never more than ten inmates, and they have since been deported from the land. All of them were Chinese, and all from South China.

A very strong proof that leprosy is not endemic in North Borneo is the fact that they have no native word for it. The Malays speak a dialect of Malay slightly differing from that of the Straits, and they certainly have no word for the disease, and always described it by the simple word *sakit*, "sickness", with the expressive pantomime of slowly blowing the nose into the hand. Educated Malays, of course, knew the word *kosta*, but were so unaccustomed to its use, and so identified the disease as a stranger, that they generally called it by the English name leprosy. A stronger proof of the foreign origin of leprosy could not be desired.

Philippine Islands.

A group of large islands bounding the eastern side of the China Sea, and comprising an area about the size of the British Isles.

Chinese immigrants form a large section of the population; in the town of Manila alone they number well-nigh 4,0000.

There is one hospital near Manila, "Hospital de San Lazaro", which was erected in the year 1577, and rebuilt in the year 1744. The hospital consists of one hundred and eighty beds, devoted exclusively to the treatment of lepers.

There seems no doubt, from the large size of the hospital accommodation, that leprosy is prevalent in and around Manila. It will be observed that here the Chinese are in enormous numbers; the chief recruiting-ground, moreover, being the leprous Chinese provinces of Kwangtung and Fokien.

New Guinea.

Sir Wm. McGregor, K.C.M.G., M.D., states that "The racial tribes are of the Melanesian (Papuan) type—

'Oriental Negroes'. Leprosy occurs sporadically anywhere, but that in twenty-seven known dialects there is no known native word for leprosy." This statement bears out the idea that leprosy must be a disease of recent introduction in New Guinea.

In a group of Polynesian Islands, *New Britain, New Ireland,* and the *Duke of York* islands, leprosy is said by Rev. William Brown to be unknown.

New Hebrides.—Mr. Michelson writes, October 1894:—

"The reply to your question is short, viz., 'I do not believe there exists leprosy in the New Hebrides'."

Dr. Fraser writes also from New Hebrides:—

"We have no cases of leprosy in this island. One of this group is sometimes called Leper Isle, but I believe it is from a false impression of the discoverer."

Friendly Islands or Tonga group, lie in the South Pacific to the eastward of Fiji.

Report by H.B.M. Vice-Consul, Tonga, October 17th, 1894:—

"I enclose my answers. There can be no doubt that the disease is not nearly so prevalent or so serious as it used to be when the population of these islands was much greater than it is now. I have not, for instance, seen a "bad" case since my advent, nearly eight years ago."

New Caledonia:—This French settlement in the South Pacific has now its quota of lepers. We have no data as to the time leprosy was introduced, but M. Mondiere, writing some twelve years ago, does not mention leprosy amongst the diseases of the natives. Leprosy is a recent importation into New Caledonia, carried thither by the opening up of trade in these regions.

Samoa.—Dr. Davies writes from Samoa:—

"The only two cases of leprosy (suspected) during the five years of my residence in Samoa occurred in the persons of Hawaiians, but the cases were both doubtful."

There seems but one way to prevent the whole of Oceania from becoming leprous, and that is the exclusion or the rigid control of all Chinese coolies. It may not be practicable to exclude the Chinese altogether; but where the very existence of the native races is involved, surely steps should be taken, and that speedily, to ensure that the coolies are not sought for in Kwangtung and Fokien, where, alas! they are most easily procured, and where they are almost certain to be tainted. We have the certain case of North Borneo, and the almost equally certain case of

Hawaii, together with Fiji and New Caledonia, as bitter warnings. If ever there was a case in which strong Governments should act strongly for the sake of the weak, it is this. A whole ocean is threatened. It has been crossed by leprosy already. Hawaii was the stepping-stone to California, and California is a new and dangerous centre for the distribution of the disease.

Gathering together tha evidence contained in the foregoing summary of leprous and non-leprous countries in the area defined, an analysis of the facts will furnish some useful lessons.

The scheme may be divided into three branches:—(1) Climatological; (2) Geological; and (3) Ethnological.

1. Climatological.

The vast area treated of in this report includes every type of climate except the arctic. It embraces climates which are temperate, as in Korea and Manchuria; tropical, as in South China; and equatorial, as in Borneo and Java. It illustrates the extremes of continental climates, with burning summers and bitterly cold winters, as in North China; as well as typical insular climates, with an equable temperature all the year round, as in the Pacific Islands. It includes every variety of humidity, from parched lands of semi-desert character, as in much of North China, to steaming jungle hotbeds, as in Borneo and the Malay states. The winds that are encountered vary from the zephyrs of the equatorial belt of calms, to the typhoon-swept China seas, and the blinding dust-storms of the north of that great empire. It includes some of the highest table-lands and some of the mightiest mountains, as well as extensive plains scarcely above sea level.

This being the case, one is driven at once to ask the question whether, if over such diverse regions leprosy is rife, climate can have anything to do with the disease.

The Temperate Region.—The temperate region in China may roughly be taken as the country north of the Yangtse River, having a mean annual temperature of about 60° F. It is continental in type, the summer temperature at Peking, for example, averaging 79° F. for the three summer months, and as low as 27° for the three winter months. It is a dry region, even the coast of Shantung only receiving about 25 inches of rain annually; and as we go west the dryness increases, till west of Peking the country is semi-desert. This is owing to the steady desiccation which Central and

East Asia is undergoing from secular causes, and to the cutting off of the rain-bearing monsoons by the mountains which divide the basin of the Yangtse from that of the Hwang-ho.

Manchuria and Korea exhibit the same continental conditions, but the latter enjoys a heavier rainfall.

Leprosy is endemic in Shantung, but not in Chihli. It is not endemic in South Manchuria, but is again found in Southern Korea; but nowhere throughout this temperate region does it attain the virulence it assumes in the tropical provinces of Kwangtung and Fokien.

We must look elsewhere than to climatic conditions to find a clue to the sporadic character of leprosy in the temperate region.

The Tropical Region.—I separate this from the equatorial because of its marked individuality. It includes all the area between the temperate region and, say, latitude 12°.

It is marked by distinctly tropical summers, with the wet season during the hot weather, and by strongly-marked seasons. The summers are not hotter than in the north, but are much moister; and the winters are cool, though frost is of rare occurrence. It is the region of typhoons.

This region includes all South China, Indo-China, and the Philippines, which latter have peculiarities of their own, rendering them more allied to the equatorial region. The rainfall is heavy, ranging from 60 inches to 160. It contains wide plains, high mountains, and the vegetation varies from almost desert to dense tropical forest and jungle.

Leprosy is endemic over most of it, and here again we see the disease sporadic. It is found in an isolated centre in the mountain province of Szechuen, and missing over the rest of the province. It is rare in all the other provinces except Kwangtung and Fokien, where it swarms. It is found in less marked intensity through Cochin, and is endemic in the Philippines.

It occurs again, but in greatly diminished force, in the central plain of the Yangtse, but is absent from the equally great and as densely peopled Yangtse plain of the east. Neither mountain nor plain affects it. The forest region of Cochin nurtures it, the forest region of Szechuen does not. The swampy rice-fields of Kwangtung are a hotbed of it, the swampy rice-fields of other places are not. Climate offers no solution of the question.

The Equatorial Region is characterised by an almost complete absence of climatic contrasts. Air, soil, and water

have a uniform temperature bordering on 80° F.; the day and night temperatures vary but a few degrees, and there is no appreciable difference of season. Everything reeks with moisture, and few storms stir the atmosphere. It is essentially the region of primeval forests. It includes all the land within twelve degrees of the equator.

Every variety of surface diversifies it, from high mountains to wide plains, but it is a region of islands, and not continental. The Malay peninsula, the Archipelago, and many islands in the Pacific lie within it.

Over this vast and diversified area common opinion believes leprosy to have laid its foul hand. A perusal of the records I have given in the previous pages will show this to be a mistaken conclusion. Still, it is only too true that the disease is very wide spread, and the Straits Settlements, Java, Sumatra, the Moluccas, and most of Celebes are leprous, and Borneo also to a lesser extent.

If any part of the world could be selected in which all the conditions for the favourable cultivation of the leprosy bacillus were favourable, one would choose the equatorial region, with its continual moist heat and rank vegetation. Yet it is not the hotbed of the disease. Nowhere is it to be found as virulent as in Kwangtung and Fokien, and even the unhappy Hawaiians belong not to this, but to the tropical region. Leprosy is rare in Java, not very prevalent in Sumatra, and its chief seat in the region seems to be in the Moluccas.

It may confidently be affirmed that leprosy is not dependent nor even influenced by climate in any portion of the area dealt with in this report.

2. Geology.

It is unnecessary, even if it were possible, to describe the geological features of this great area in even a general sketch.

In China we have mountain and hill regions having a granitic core, over which are laid extensive beds of archæan schists and limestones, slates and sandstones. The greater part of the empire is covered with rocks of Carboniferous age, vast areas being composed of mountain limestone and coal-measures. Next in importance to these are the extensive post-Tertiary sands and loess which form the Great Plain.

Similar rocks (with the exception of loess) are found in the Malay Peninsula, Borneo and Sumatra, and in the two latter thick beds of Tertiary sandstone abound.

Volcanic rocks are illustrated on the grandest scale in Java, the lesser Sunda Islands, the Moluccas, and the Philippines.

The Pacific is equally rich in volcanic rocks, and is, in fact, entirely composed of them or of coral. The continental island of New Caledonia is an exception.

We have thus every possible formation, or rather every kind of rock, amply illustrated. On the one hand are the deadly mangrove swamp, the bright coral strand, the alluvium of mighty rivers, and the loess, to illustrate modern formations. Granite, as in Kwangtung, Fokien, and Shantung, are examples of plutonic rocks; the volcanic series is nowhere better developed, and ordinary sedimentary rocks take the ground over many thousands of square miles. Yet this variety bears no relation to the distribution of leprosy.

Decomposing granite has, in the East, many charges brought against it as a seed-bed of disease. I have never been able to see the faintest evidence in this direction. It is true that the coasts of Kwangtung and Fokien are chiefly granitic, and that they are the most leprous of places. It is true that leprosy crops up again in Shantung, where granite is found. But leprosy in its intensest form is as rife on the Carboniferous rocks and on the modern alluvium of Kwangtung as on the granite; and in Shantung the comparatively mild leprosy is spread over the modern loess and marine sands even more than over the small granite area.

North Celebes is free from leprosy, while South Celebes is tainted; and the former is volcanic, the latter is not. Here, if we only had limited knowledge, we might trace a connection between the rocks and the disease. But the Moluccas, where the severest form of leprosy in the Archipelago is said to occur, is entirely volcanic; and so are the Sandwich Islands. There is no practical geological difference between the geological structure of Sumatra and Java, where leprosy exists, and the lesser Sunda Islands, where it does not.

In conclusion, I have no hesitation in saying that geological structure does not exercise influence over the distribution of leprosy.

3. Ethnology.

The ethnology of the area treated of is very interesting. It embraces most of the chief races: the Caucasian, the Mongolic, the Negroid, and the Indonesian.

A. *Mongolian.*

(1) Mongolian:

Chinese.	Loas.
Siamese.	Annamese.
Shans.	Burmese.

(2) Malay:

Malay proper.
Tagalas and Biscayans of the Philippines.

B. *Caucasic.*

Natives of Cambodia and Champa.
Klings from Madras.

C. *Indonesians.*

Battaks, Kubus, and Passumahs of Sumatra.
Mantawi Islanders.
Most Dyak tribes.
Buludupies of North Borneo.
Indigenes of Celebes.
Galelas of Jilolo.
Many tribes in Buru, Ceram, Savu, Roti, etc.
Some tribes in the Philippines.
Red-haired tribe of East Timor.
Polynesians of Samoa, Tahiti, Hawaii, Tonga, etc.

D. *Negroid.*

(1) Negritoes:

Aetas of Philippines.
Jacuns, or Sakais, of Malay Peninsula only.
Karons of New Guinea.
Badui and Kalongs of Java.

(2) Papuans:

Generally distributed from Flores to Fiji.

The waves of life which have passed over this part of the earth cannot yet be determined in detail, but the general facts are as follows:—Originally the entire area, except perhaps the Eastern Pacific, was peopled by the black race that has since diverged into two varieties, the Negritoes and the Papuans. Then the brown race, of whom the Malays are considered the type, appeared on the scene, but not as true Malays. The immigrants who have been styled pre-Malays, and are now spoken of as Indonesians, have strong affinities with the fair Caucasic stock, and are probably a fusion of Mongolic with Caucasic elements. Next, the true Malays spread from their birthplace, and about the second century B.C. a wave of Buddhism and Brahminism affected the Archipelago, leaving traces in

Cambodia, Java, Borneo, and as far east as Moluccas. In the thirteenth century Islam began to spread, and at the same time the Chinese began to push southwards. Then followed the Portuguese, Spaniards, Dutch, and English.

The area is therefore a complex one to deal with ethnologically, yet certain broad facts become apparent.

The first point is that leprosy is absent from the area occupied by the Negroid races, with two exceptions. Thus it is absent from the lesser Sunda Islands, also from the Caroline Islands, the Solomons, and the New Hebrides. But it is present in part of New Caledonia and Fiji. In other words, it is absent from all the area in which plantations, or Chinese intercourse, is also absent, and crops up where European or Chinese influence holds sway.

If we take the Indonesian area the same fact comes to light. Leprosy is practically absent from the whole of Borneo, save where the Chinese have settled. In Sumatra the Indonesian area, again, is free from leprosy so far as these people are concerned; though one might be misled to consider the whole island as leprous because cases occur in most districts, though the aborigines are free from the disease. So, too, Timor, with its mixed Papuan and Malay population, and even with a small Indonesian element, is free.

It is not till we come to the Chinese and Malay localities that leprosy marks itself strongly on the land, and the universal testimony is that it is the Chinese who are the greatest sufferers, and that the Malays are little affected by it. Every hospital, whether in Borneo, Sumatra, or Java, tells the same tale: the Malay patients are few, the Chinese form the bulk of the lepers. This I believe to be the case in the Moluccas, though I have few data to go upon. Mr. Skertchly never saw a native leper there.

If we turn to the Pacific Ocean we find three centres of leprosy—New Caledonia, where it is rare; Fiji, where it is very rare; and Hawaii, where it attains a virulence more intense than in Kwangtung. Now, what do these facts show? They tell the same story that leprosy has spread with the incoming of foreign races. In the case of Hawaii, though much has been written to the contrary, I think no unprejudiced person can weigh the evidence which is given in detail in the report on those islands, and doubt, for a moment, that leprosy was brought by the Chinese. I have shown this to be the case in North Borneo, it is the common belief in Sumatra and Java, and even in the Malay Peninsula we find most of the lepers are Chinese; the Malays

are affected but to a slight extent, and the aborigines not at all, with one doubtful but remarkable exception, the Sakais of Muar; and Muar, be it remembered, is on the frontier of Malacca—the oldest European settlement in this part of the East.

Reviewing the evidence from an anthropological point of view, it seems that certain broad facts may be taken as fairly well established, though it is highly desirable to obtain further information, especially in the Pacific.

The almost complete immunity of the region occupied by the Negroid races, and the almost equally marked immunity of the Indonesians, the two oldest races in the area, seem to show that leprosy is not indigenous to the Archipelago or the Pacific, but has been introduced recently.

Next, the fact that the Malays suffer so little in comparison with the Chinese, and, moreover, only where the Chinese have settled, shows that it is to the Chinese and not to the Malays that the spread of leprosy is due.

I would here make another suggestion. The Chinese have visited Borneo for the last six hundred years, and many settled permanently in the north and west, and have fused with the native tribes, yet leprosy is unknown there; and much the same thing has happened in other parts of the Archipelago, no evil results having been felt. If it be asked why this immunity, perhaps an answer may be found in this suggestion: there is a great difference between voluntary immigrants and forced immigration. The Chinese who in early days came to Borneo came to trade, and were by no means of the coolie class, and therefore were not likely to be lepers.

The coolie traffic, though better than it used to be, savours still of the pressgang rather than of volunteering. It is the poor starving wretches that are conveyed to the plantations, and it was when they were introduced into Borneo that leprosy appeared. The free emigrating Chinaman never went to a native island as a coolie; he went as a trader or planter,—as a master, not as a slave. It was not till forced labour was introduced by the European that leprosy began to spread; and on this suggestion the peculiarities of its distribution receive a natural and sufficient explanation.

N.B.—In the part of the report devoted to geology and ethnology the writer had the benefit of the co-operation of Mr. Skertchly, the well-known geologist.

THE HISTORY OF TYPHOID FEVER IN MUNICH.

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(*Read: January 21st*, 1898.)

THE history of typhoid fever in Munich during the last fifty years is for many reasons of the greatest interest. The extraordinary prevalence of this disease in the city during the sixth, seventh, and eighth decades of this century, and its extraordinary reduction since 1880, probably present a unique record in epidemiological history. Especial interest is added to this record by the fact that Professor von Pettenkofer and his school concluded long ago that no connection could be traced between the incidence of typhoid fever and the distribution of the drinking water in the city, but that a very distinct causal relation was indicated between the incidence of the typhoid fever and the conditions of the soil. There is probably no place in the world which has afforded, or can afford, such opportunities for deciding how far the character and distribution of the water-supply have contributed to the production and reduction of epidemics of typhoid fever; and since the conditions of the disease-incidence, of the soil, and of the water-supply have been most carefully and systematically observed by Pettenkofer and other high authorities in Munich during the last forty years, their records are worthy of the attention of every student of epidemiology.

From Tables I and II it will be seen that the mean annual mortality from typhoid fever per 100,000 inhabitants in Munich was:—

202.4	in the	sixth decade.
147.8	„	seventh „
116.7	„	eighth „
16.0	„	ninth „
5.6	„	period 1891-1896.

It will be noticed that the course of the disease was varied by large epidemic waves, which extended over periods of nine, seven, nine, and five years respectively.

TABLE I.

Deaths from Typhoid in Munich.

Year.	Inhabitants.	Annual.	Per 100,000 Inhabitants.
1851	123,957	123	99
1852	125,588	152	121
1853	127,219	235	184
1854	128.850	293	227
1855	130.481	253	193
1856	132,112	384	291
1857	133,847	390	291
1858	135,733	453	334
1859	137,005	240	175
1860	140,624	153	109
1861	144,334	172	119
1862	148,200	300	202
1863	154,602	252	163
1864	160,828	397	247
1865	167,054	338	202
1866	168,265	342	203
1867	169,476	88	52
1868	170,688	136	80
1869	170,000	190	111
1870	170,000	254	149
1871	170,000	220	129
1872	169,693	407	240
1873	175,500	230	131
1874	181,300	289	159
1875	187,200	227	121
1876	193,024	130	67
1877	205,000	173	84
1878	211,300	116	55
1879	217,400	236	109
1880	223,700	160	72
1881	230,028	41	18
1882	236,400	42	18
1883	242,800	45	19
1884	249,200	34	14
1885	255,600	45	18
1886	262,000	55	21
1887	268,400	28	10
1888*	292,800	31	10.5
1889	306,000	31	10.1
1890	331,000	28	8.5
1891	357,000	24	6.4
1892	372,000	11	3.0
1893	385,000	57	14.8
1894	393,000	10	2.5
1895	400,000	15	3.7
1896	412,000	14	3.4

* This Table is taken from von Pettenkofer's *Munich a Healthy City*, up to 1887 inclusive; after 1887 from returns obtained from the Statistical Bureau.

These waves gradually decreased in magnitude, and towards the end of 1880 collapsed abruptly: they have not risen again.

The mean annual typhoid mortality, which had been 116.7 in the eighth decade, was suddenly decreased to 16, so that the mean annual typhoid mortality of the ninth decade was less than one-seventh of what it was in the eighth.

During the six years 1891-96 it has been still further reduced to 5.6, *i.e.*, less than one-twentieth of what it was in the eighth decade.

During the last three years it has been only 3.2.

The epidemics may be said to have ceased in the autumn of 1880.

TABLE II.

Deaths from Typhoid Fever in Munich.

—	Total.	Total Annual Mean.	Annual Mean per 100,000.
1851 to 1860	2,676	267.6	202.4
1861 to 1870	2,469	246.9	147.8
1871 to 1880	2,188	218.8	116.7
1881 to 1890	383	38.3	16.0
1891 to 1896	131	21.8	5.6

The mean annual death-rate from typhoid fever per 100,000 in England and Wales has decreased considerably since 1870, but not nearly so much as in Munich.

This rate was:—

32.55 in the eighth decade.
19.76 „ ninth „
17.38 „ period 1891-1895;

i.e., there was a reduction in the ninth decade nearly to one-half of what it was in the eighth; since 1890 the reduction has been continued to a very slight extent.

Whilst in England and Wales the reduction has been nearly to one-half, in Munich it has been more than twenty-fold.

Evidence indicating that the Records of this extraordinary reduction of Typhoid Mortality in Munich have not been miscalculated or exaggerated owing to errors in diagnosis:—

The eminent pathologist, Professor von Buhl, drew up lists showing the monthly averages of death from typhoid

fever which occurred in the Munich hospital, and were verifed by post-mortem examination during the years 1854 to 1864.

Von Pettenkofer drew up similar lists of monthly averages of the deaths from typhoid fever recorded by the Munich physicians as occurring in the whole city during the years 1851 to 1867, and compared them with the lists of von Buhl.

Table III shows these lists compared together. If the diagnosis of the cases recorded in the whole city were correct, it might be expected that the monthly averages of these cases—taken over a long period of time—would bear an approximate ratio to the monthly averages recorded and verified in the hospital.

As seen in Table III, the conformity between these ratios is very remarkable.

TABLE III.

Showing the Monthly Average of Cases of Death from Typhoid Fever.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	—
(*a*)	33.5	36.8	31.8	23.1	17.6	15.2	15.8	16.7	16.1	15.0	19.0	28.5	In the whole city.
(*b*)	13.1	14.1	12.4	6.9	5.2	5.2	6.0	4.8	6.8	4.2	7.6	12.2	In the hospital.
(*c*)	12.8	14.1	12.2	8.8	6.7	6.7	6.0	6.4	6.2	5.7	7.3	10.9	*In the whole city* ÷ 2.61

(*a*) Recorded in the whole city of Munich from 1851 to 1867 (von Pettenkofer).

(*b*) Recorded in the hospital and verified by *post-mortem* examination during the years 1854-1864 (by von Buhl).

(*c*) Recorded in the whole city (as above); divided by the factor 2.61 :—
The factor 2.61 is obtained by dividing the maximum monthly average of the whole city by the maximum of the hospital.

The great and unmistakable decrease of typhoid fever in Munich is confirmed by chief staff-surgeon Dr. Port's careful observations of the progress of the disease in the garrisons of the city : *vide* Table IV.

The great decrease of typhoid fever in Munich during the ninth decade is also corroborated by v. Ziemssen's tables, which show that the decrease of morbidity (as indicated by the number of cases of typhoid admitted to the hospital) was even a little greater than the decrease of typhoid mortality, as recorded in the whole city.

TABLE IV.

Mortality from Typhoid Fever in the Munich Garrisons, from 1850 *to* 1881.—*(Port: Archiv. f. Hyg., 1883, p. 67).*

Year.	Strength	Deaths in Year.	Per 1,000.	Year.	Strength.	Deaths in Year.	Per 1.000.
1850	5,876	41	7.0	1874	6,615	71	10.7
1851	6,030	44	7.3	1875	6,380	29	4.5
1852	5,476	37	6.7	1876	5,944	9	1.5
1853	5,592	62	11.1	1877	5,637	19	3.4
1854	5,380	61	11.3	1878	6,130	2	0.3
1855	5,445	77	14.1	1879	6,066	22	3.6
1856	4,875	29	18.2	1880	5,997	6	1.0
1857	4,828	58	10.8	1881*	5,490	0	0.0
1858	4,931	80	16.2	1882	6,848	2	0.3
1859	5,901	59	10.0	1883	7,035	1	0.14
1860	5,781	31	5.3	1884	7,112	3	0.42
1861	5,719	24	4.2	1885	6,820	1	0.15
1862	5,582	55	9.8	1886	6,552	1	0.15
1863	5,300	27	5.1	1887	6,912	2	0.29
1864	5,312	62	11.6	1888	7,527	2	0.26
1865	5,090	21	4.1	1889	7,395	0	0.00
1866	—	57	—	1890	7,398	2	0.27
1867	5,646	8	1.4	1891	—	—	—
1868	—	23	—	1892	—	—	—
1869	6,188	33	5.3	1893	—	—	—
1870	(½)—	15	—	1894	—	—	—
1871	(½)—	14	—	1895	—	—	—
1872	5,523	55	9.9	1896	—	—	—
1873	5,915	42	7.1				

* Schuster, *idem.* 1893, p. 502.

The mortality from typhoid fever per 1,000 men in these garrisons in the sixth decade was 11.80; in the seventh decade was 5.93; in the eighth decade was 4.67; and in the ninth decade was 0.19.

TABLE V.

Von Ziemssen's Tables.

——	Period.	Total No.	Annual Mean.	Ratio of the Annual Means.
(1) No. of deaths from Typhoid Fever recorded in Munich	(A) 1866-1880	3198	213.2	5.31 to
	(B) 1881-1883	321	40.1	1.00
(2) No. of cases of Typhoid admitted to Hospital ...	(A) 1866-1880	8932	595	5.72 to
	(B) 1881-1888	831	104	1.00
(3) Mortality per 100,000 recorded in the city ...	(A) 1866-1880	...	117.4	7.33 to
	(B) 1881-1888	...	16 0	1.00
(4) No. of cases admitted to hospital per 100,000 inhabitants	(A) 1866-1888	...	332	7.909 to
	(B) 1881-1838	...	42	1.00

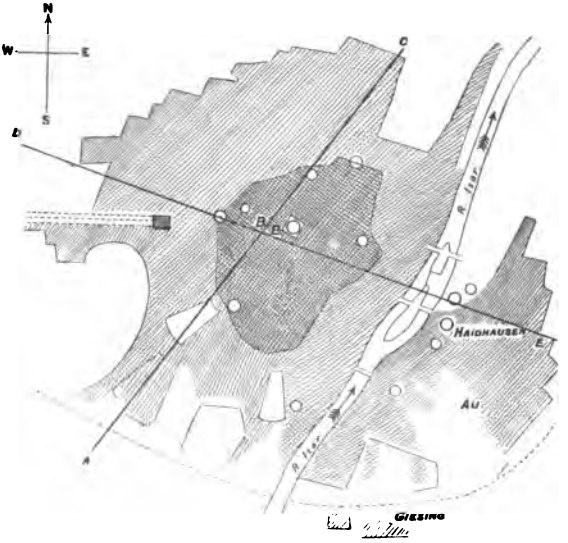

Fig. 1.—MAP OF MUNICH.

The diagonal lines indicate the inhabited parts of the city. The darker centre indicates the old city. The sources of the public water-supplies are indicated by circles. B B marks the well in the Courts of Justice (Stadtgerichtshof).

Fig. 2.—Geological Section of Munich through the line A B C in the Map (Fig. 1), showing the approximate height and flow of the subsoil water.

Fig. 3.—Geological Section of Munich through the line D B E in the Map (Fig. 1), showing the gravel bed on which the city is built.

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THE CITY OF MUNICH AND ITS SURROUNDINGS.

Situated about 1,700 feet above the sea, on a plateau which slopes gently northwards from the Alps towards the valley of the Danube, Munich is built on the old gravel bed

of the river Isar. About four-fifths of the city (including the oldest part) lie on the left or west side of the river, the remaining fifth being built on the more highly situated bank on the right.

This gravel bed varies in thickness from about 10 ft. in the northern part of the city to about 50 ft. and more in the southern part.

Immediately beneath the gravel is extended a vast stratum of impermeable marl (named "Flinz"). Over the surface of the marl flows the subsoil water ("Grundwasser"), a great subterranean stream, not only underlying the whole city, but extending for great distances beneath the surface of the Munich plateau.

This subsoil water has its source chiefly from the wide expanse of uninhabited area, which extends at a higher elevation to the south of the city. It flows in a north-easterly direction, almost parallel to that of the river Isar.

The level of the subsoil water is liable to variations, remotely dependent on the preceding rainfall. The range of these oscillations extends from 0 up to about 8 ft.; more usually, however, only from 1 ft. to 2 ft. They show remarkable uniformity throughout the area of the whole city.

Speaking generally, the level of the subsoil water is highest in the summer and autumn, lowest in the winter months.

The surface of the impermeable Flinz slopes gently downwards in a northerly direction (though not so much as the surface of the soil), and presents many inequalities —elevations, depressions, and horizontal stretches—which greatly modify the depth and current of the subsoil water. When the level of the subsoil water is low, it stagnates in some of the depressions, leaving some of the elevations dry; whereas, when the level is high, it flows freely over the inequalities, washes through and cleanses the overlying gravel, removing from it the impurities which have accumulated during the previous drought.

Chemical analysis shows the subsoil water to be of comparative purity before it enters under the area of the city (see Table VII, *b* & *c*); as it enters under the inhabited parts it shows signs of great and increasing pollution (see Table VII, *f*, *g* & *h*).

Exceptions to these rules are found in the subsoil water in those districts adjoining the river Isar, where it has been shown, from its exceptional purity and from the variations

in its level, to be derived directly from the river (see Table VII, *e*, *m* & *n*).

It has been found to be purer as a rule when it falls, more polluted when it rises.

Numerous branches of the Isar still flow through the heart of the city, forming a meshwork of streams ("Stadtbäche"), which run with great swiftness through and around the older part, covered generally by the streets and buildings, but coming here and there into view; and reuniting to the south of the city to form larger streams which discharge eventually into the Isar.

Drainage of Munich during the Sixth Decade.

From time immemorial until 1858 nearly all excreta were deposited in privies and cesspits, so constructed that their liquid contents drained away into the porous soil.

By similar arrangements the slops and liquid refuse from the houses were allowed to soak away into the soil.

The remaining refuse appears to have been discharged into the city streams and the river.

In 1858 an order was issued that all cesspits in the city should be made watertight. The inspection, emptying, and repairing of these cesspits was entrusted to the officials of the municipal authorities. This order could only be carried out by degrees. The slops and other liquid refuse from houses, etc., were still committed chiefly to the soil until 1878; but from that year up to the present time they have gradually been cut off from the soil and conveyed into the city sewers.

Until 1858 only the old city, and some of the suburbs on the right of the Isar, appear to have had sewers. After that time the systematic drainage of those parts surrounding the old city (Max-vorstadt and Ludwig-vorstadt) was begun and carried on until 1878. Since then—from 1881 up to the present time—the sewerage and house-drainage of the rapidly growing city have been gradually improved and carried out according to the plans of the English sanitary engineer, Gordon.

Since 1893 the old watertight cesspits have been rapidly replaced by water-closets. In 1878, some 800 slaughter-houses within the city, nearly all of which poured their organic refuse into the soil, were removed. They were replaced by a model, well-drained slaughter-house outside the city.

WATER-SUPPLIES OF MUNICH: FROM 1851 TO 1865.

During this period, and from the beginning of the century, the city was supplied with drinking water entirely from the subsoil water—partly by the Royal waterworks (seven in number), partly by the municipal waterworks (six in number), and partly by private wells. Three of the Royal waterworks collected water from three different springs on the east side of the river, and four from four large wells in different districts of the old city.

The chief of the municipal waterworks was supplied from springs on the right side of the Isar; a small spring on the same side of the river supplied the adjoining suburb of Au; the remaining four municipal waterworks derived their water from wells either in or immediately outside the old city. All these sources were more or less surrounded by houses and other buildings, and subject to constant pollution from leaking cesspits, house-refuse, slaughter-houses, etc.

The sources on the right bank of the Isar, which was comparatively thinly populated, were not liable to such extensive pollution as the wells of the old city. Yet the crude analyses made at this period showed that they were contaminated with a large amount of organic matter.

The analyses of all these wells, springs, and other sources which have been made up to the present time—with few exceptions—show evident signs of organic pollution.

In 1865, a considerable water supply was added to the southern and western districts of the city by the Pettenkofer Waterworks, the water being derived from subsoil springs in the southern area above the city, an uninhabited district. The analysis of this water (see Table VII, *b*), illustrates the purity of the subsoil water, before it is contaminated by the city.

It was not until 1883 that the present fine water-supply (the "Hochquelle leitung") was introduced, the water being derived from springs and streams impounded in the Mangfall valley of the Bavarian Alps (about twenty miles away).

This water has been gradually distributed to the different parts of the city, and has now supplanted nearly all the old water supplies. Its analysis shows it to be of exceptional purity (see Table VI *p*).

From a study of the large number of chemical analyses of the water supplies of Munich, recorded in the *Zeitschrift f. Biologie* and elsewhere, during the seventh and eighth

decades, it may be seen that the pollution was very large and general, the evaporation-residues varying from about 40 per 100,000 to nearly 200.

In 1892 the analyses of the wells still existing in Munich (over 1,300 in number) was undertaken by Dr. Sendtner and a staff of assistants.

Some of these analyses made in 1892 have been selected, and are recorded in Table VI.

A study of the 1342 chemical analyses of the wells in Munich in 1892* would be of great interest to water-analysts. It is obvious that the subsoil-water, which until 1883 supplied nearly the whole city with drinking-water, must have shared largely in the gradual and general purification; and, indeed, a study of the chemical analysis of the 1,342 wells of the city will show that the pollution of the great majority of these wells is due more to the presence of effete and oxidised organic matter than to recently contributed organic pollution. This fact is well illustrated in the case of the well in the Courts of Justice (Stadtgerichtshof): *vide* Fig. 1 and also Table VI *g*. The analysis of this well shows that the nitrates (calculated as potassium nitrate) formed more than one-third of the evaporation residue, and the chlorides (calculated as potassium chloride) rather more than one-sixth. The oxidisable matter, on the other hand, is very small in amount, and no traces of ammonia or of nitrites were found. In the majority of the highly polluted wells, whilst the amounts of evaporation residue, of chlorine, and of nitrogen as nitrates are very great (viz., from 100 to 150, from 5 to 18, and from 1 to 7 parts per 100,000 respectively), no trace of ammonia or of nitrites has been detected, and the amount of oxygen required (for oxidation of the organic matter) has frequently been less than 0.2 parts, and seldom above 0.4 parts per 100,000.

Unfortunately, I have not been able to discover many records of the amounts of chlorine, ammonia, nitrites, nitrates, and oxidisable matter in the earlier analyses. But Dr. Sendtner, in his book (pp. 62-68), gives the analyses which he made between 1880 and 1890 of seventy-five wells. In these analyses the presence of ammonia and of nitrites in large quantities (indicating recent organic contamination) is frequently recorded, in striking contrast to the 1,342 analyses made in 1892—*i.e.*, some ten years later —in which traces of ammonia and nitrites are rarely

* Sendtner, *Das Grundwasser in den einzelnen Stadttheilen München's*, 1894.

TABLE VI.

Chemical Analyses of the Drinking Waters of Munich (parts per 100,000).

Date.	Source.	Residue dried at 100° C.	Chlorine.	NH_3.	Nitrites.	N as Nitrate.	Oxygen required.
1892							
(*a*)	Isar River...	20.9	0.15	—	—	0	0.21
(*b*)	Pettenkofer Waterworks ("Thalkirchner Wasser")	27.2	1.0	—	--	0.3	0.09
(*c*)	"Normal" subsoil water	32.5	1.4	0	0	0.25	0.2
(*d*)	Royal Waterworks (from springs on right side of Isar). Mean of 23 samples	47.3	1.93	0	0	1.15	0.082
(*e*)	No. 17, Erhardt Str. (close to River Isar)	17.6	1.184	0	0	traces	—
*(*f*)	No. 28, Lindwurm Str. (near south end of city)	34.0	1.45	0	0	0.70	0.054
*(*g*)	Courts of Justice ("Stadtgericht hof"): in heart of old city	62.0	5.04	0	0	3.02	0.042
*(*h*)	No. 10, Amalien Str. (in south end of city)	82.4	7.27	0	0	3.7	0.102
†(*k*)	Well at north-west end of city, 186, Nymphenburg Str.	33.2	0.81	0	0	0.48	0.05
(*l*)	In city, near railway station, 4, Luitpold Str.	86.6	5.82	0	0	6.40	—
†(*m*)	On Kalkofen Island (in the river Isar)	17.0	0.48	0	0	traces	0.075
†(*n*)	In city, near the river, 54, Baader Str.	26.8	0.58	0	0	0.37	0.183
†(*o*)	In suburb, Haidhausen, to east of river Isar, 125, Rosenheimer Str.	33.4	0.97	0	0	0.61	0.015
1886							
(*p*)	The "Hochquelleleitung", the new highland water supply to Munich	30.0	0.45	0	0	0.18	0.08

* Near the line A B C in the Map (Fig. 1).
† Near the line D B E in the Map (Fig. 1).

Methods of Analysis Used.—Residue, by drying at 100° C. in an air-bath ;

reported. In an analysis of the Stadtgerichtshof well recorded by Pettenkofer,* and dated 1871, the oxidisable matter is greater, the nitrate far less, than it was in 1892; indicating that it was still subject to some active organic pollution in the earlier period, whilst only effete and oxidised organic matter is contributed to the water at the present time. This well is of very special interest. It may be taken as an average sample of the many wells which formerly existed within the city. It was in much request because of its coolness and fine flavour. Standing in the centre of a courtyard of what was formerly a convent—in the heart of the old city—it was surrounded by numerous cesspits and other sources of organic filth and excremental pollution. The analyses of the water, which have been made at very frequent intervals during the last fifty years, have always shown a large amount of contamination. The evaporation residue has generally varied from 60 to 65 parts per 100,000. (In 1892 it was 62.) The highest amounts recorded were between the summer of 1866 and the winter of 1868, a time when the typhoid incidence of the epidemic periods was extraordinarily low. It reached as much as 111 parts per 100,000 in the summer of 1867, when the typhoid incidence of those periods was at its very lowest. (At this same time there were signs of greatly increased pollution in nearly all the analyses of wells which I have been able to find.) Pettenkofer frequently calls attention to the fact that he could never find that the consumers of this well water at any time suffered more or less from typhoid fever than those deriving their water-supply from other sources.

Von Pettenkofer's Researches.

Beginning in 1854 as a believer in the constant convection of typhoid fever and cholera by the drinking water, von Pettenkofer first turned his attention to the distribution of cholera during the great epidemic of that year. He expected to find exceptional opportunities for proving the

chlorine, by Mohr's method (with silver nitrate); ammonia, by direct addition of Nessler's reagent; nitrites, by zinc-iodide and starch solution; nitrogen as nitrate, with diphenylamine, or by the Marx-Trommsdorff method (with indigo), or by the Schulze-Tiemann method (with ferrous chloride); oxygen required, by Kubel's method (by boiling for five minutes exactly with potassium permanganate, and hydrogen sulphate, and subsequent titration with hydrogen oxalate).

* *Zeitschrift für Biologie*, vol. x, p. 451.

[illegible] the measurements of well [illegible] Pettenkofer* and later [illegible]. The oxidisable matter is greater [illegible] less than it was in 1892; [illegible] that it was [illegible] to some active organic [illegible] in [illegible] earlier period, whilst more effete and oxidised organic matter is contributed to the water at the present time. This well is of very special interest. It may be taken as an average sample of the many wells which formerly existed within the city. It was in much request because of its coolness and fine flavour. Standing in the centre of a courtyard of what was formerly a convent—in the heart of the old city—it was surrounded by numerous cesspools and other sources of organic filth and excremental pollution. The analyses of the water, which have been made at very frequent intervals during the last fifty years, have always shown a large amount of contamination. The evaporation residue has generally varied from 60 to 65 parts per 100,000. (In 1892 it was 62.) The highest amounts recorded were between the summer of 1866 and the winter of 1868, a time when the typhoid incidence of the epidemic periods was extraordinarily low. It reached as much as 111 parts per 100,000 in the summer of 1867, when the typhoid incidence of those periods was at its very lowest. (At this same time there were signs of greatly increased pollution in nearly all the analyses of wells which I have been able to find.) Pettenkofer frequently calls attention to the fact that he could never find that the consumers of this well water at any time suffered more or less from typhoid fever than those deriving their water-supply from other sources.

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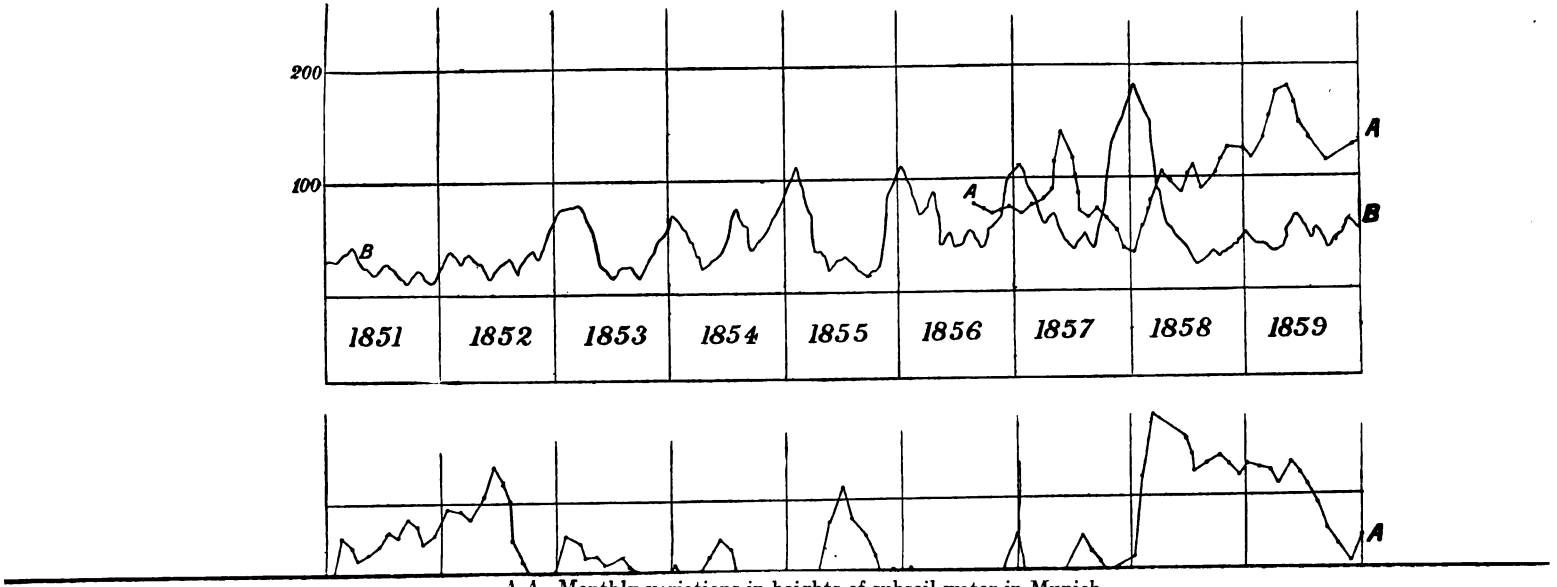
* [illegible], vol. x, p. 451.



A A, Monthly variations in heights of subsoil water in Munich.
B B, Monthly variations in typhoid mortality per 100,000 in Munich.

truth of the drinking-water theory, owing to the number and peculiar distribution of the many different water-supplies in the city. He ascertained the water-supply of each single house by means of the Royal and Municipal Water Rates, and by personal inspection; but in all cases his expectations were disappointed and he could find no connection, local or temporal, between the water-distribution and the cholera outbreaks (*Verbreitungsart d. Cholera*).

He made similar investigations with regard to the typhoid incidence in Munich and the distribution of the different water-supplies, and always with similar results. He could never trace any of the local outbreaks, which frequently occurred, to any of the many separate water-supplies.

Finally, he was convinced that in Munich there was not the slightest connection between the drinking water and the typhoid fever.

He next turned his attention to the conditions of the soil. In 1856 the observations of the height of the subsoil-water in various parts of the city were begun; these have been continued up to the present time.

In Fig. 4 the monthly returns are represented:—

(1) of the height of the subsoil-water in Munich;

(2) of the number of deaths from typhoid fever.

From this chart it will be seen that there is a remarkable correspondence—

(*a*) between the rise of the subsoil-water and the fall of the typhoid prevalence; and *vice versâ*—

(*b*) between the fall of the subsoil-water and the rise of the typhoid prevalence; until the time when the epidemic waves began to subside.

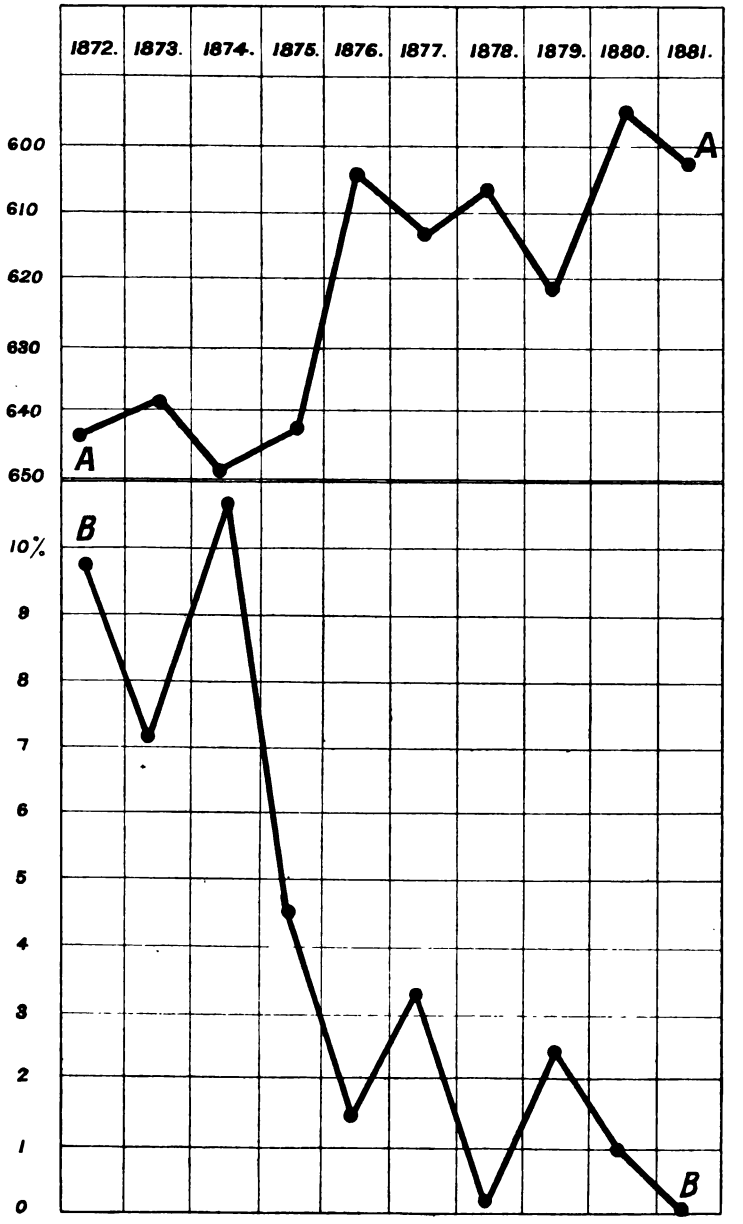
Thus a rapid fall in the subsoil-water is followed by a great outbreak of typhoid fever, as shown especially in the winters of 1857-1858 and 1865-1866; a rapid rise of the water by sudden decrease of the epidemic, as shown especially in the early months of 1858 and 1866. Whilst the subsoil water is at a high level the typhoid fever prevalence is at its lowest—*e.g.*, during the years 1860 and 1861, 1867 and 1868. During the winters of 1871, 1872, 1873, and 1874, the rapid fall of the subsoil-water is followed in each instance by considerable epidemics. After 1874 the fall of the subsoil-water appears to be followed by abortive and irregular attempts at epidemics until 1880; after which year they ceased altogether.

This constant relation between the variations of the level of the subsoil-water and the variations in the typhoid

Fig. 5. (*Archiv. f. Hyg.*, Bd. i., 1883.)

A A. Mean annual level of the subsoil-water at the Military Hospital, in centimetres below the surface.

B B. Typhoid mortality (per 1,000 men) in the Munich Garrisons, 1872–1881.



mortality is confirmed in a remarkable manner by Dr. Port's observations on the typhoid mortality in the Munich garrisons during the ten years, 1872-1881, as recorded in Fig. 5.

Von Pettenkofer's Theory with regard to the Conditions necessary for the spread of Typhoid Epidemics:—

(*a*) The presence of the specific typhoid poison in the soil;

(*b*) Pollution of the soil, together with certain conditions of porosity affected by temperature and moisture, or oscillations of the subsoil-water;

(*c*) The presence of inhabitants predisposed to the disease.

He does not consider the subsoil-water in itself as favourable in any way, but only as an index of the humidity and of certain unknown conditions and processes in the soil above it. In his opinion, if the conditions of moisture and of the soil are favourable, epidemics of typhoid may occur even where there is no subsoil-water at all.

The great decrease of typhoid fever in Munich since the sixth decade must be attributed chiefly to the removal of those causes which for so long had been producing extraordinary dampness and pollution of the soil immediately around and beneath the dwellings of the whole city.

From the time when the cesspits were made water-tight (in and after 1858), the reduction of active pollution must have been enormous; whilst the natural agencies of the soil, aided by the system of sewerage, which has been extended throughout all parts of the city, must have gradually diminished the accumulated stock of dampness and organic saturation.

Finally, the sudden abolition of the eight hundred slaughter-houses in the city in 1878 removed the chief remaining active agent of soil-pollution.

It will be well here to review the evidence which indicates that the prevalence and reduction of the typhoid fever in Munich have been independent of the drinking water.

In the first place, there are von Pettenkofer's own observations, made in 1854 and afterwards, from which he concluded that, in spite of his searching investigations, no connection could be traced out between the distribution of the drinking water and the incidence of typhoid.

So also he observed that those who made use of the Pettenkofer Waterworks water (which was introduced in

1865 and was immediately followed by a great epidemic), suffered just as much from the epidemic as those who continued to drink the old water-supplies. Of these personal observations I have not succeeded in finding recorded details; but they derive their weight from the high authority of von Pettenkofer himself.

For confirmatory evidence of these conclusions we have the chemical analyses made by Wagner and Aubrey of a large number of wells over a long series of years, from which they were led to announce the general rule that the subsoil water was more polluted when it was high than when it was low; *i.e.*, that during the periods of typhoid epidemic the drinking-water was purer than when the typhoid-incidence was small.—(*Zeit. f. Biol.*, Bd. ii, etc.)

Further corroborative evidence is derived from the remarkable results obtained by Dr. Port with regard to the Munich garrisons, as shown in Table VIII. From this table it will be seen that those garrisons which were supplied with exceptionally pure water during the ten years 1872-1881, suffered far more severely than those whose water-supply was obviously highly polluted.

TABLE VIII.

Chemical Analysis of the Water Supplies of the Munich Garrisons, and Mortality from Typhoid per 1,000 *Men*, 1872-1881.

Garrisons.	PARTS PER 100,000. Residue at 100° C.	Organic Matter.*	N as Nitrates.	N_2O_3.	NH_3.	Chlorine.	Typhoid Mortality per 1,000 Men.
Max II ...	60—77	2.5—6.0	1.25—1.7	Traces	Traces	2.8—3.6	1.2
Turken ...	47–72	1.8—2.8	1.7 —2.25	0	0	2.8—3.5	3.9
Salztadel...	60—63	1.8—2.0	1.25	0	0	2.4—2.6	—
Hofgarten	27—45	2.5—5.0	0.8 —1.5	0	0	2.1—2.1	7.1
Lehel ...	50—58	5.0—5.6	0.8 —0.9	0	0	1.7—2.1	2.8
Neue Isar	28—35	1.1—4.1	0.15—0.9	0	0	1.0—1.8	10.6
Alte Isar...	20—29	1.0—3.0	0.03 –0.05	0	0	0.8	7.4

—*Archiv f. Hyg.*, Bd. i, 1893.

Finally, there is the great fact that the people of Munich were drinking the subsoil water, and that only, until 1883, —three years after the epidemic-waves had ceased,—when the highland water-supply was introduced. This supply has gradually been distributed to the whole city.

* "Organic matter" = amount of potassium permanganate required, multiplied by 5 (*Wood'sche Zahl*).

In 1884 von Pettenkofer investigated the typhoid mortality in 871 houses, containing 23,302 people, who were still supplied by the old Royal Waterworks. These waterworks had not altered their supply in any respect. He found that "they did not suffer more from typhoid than their fellow citizens who drank of the pure highland water-supply".—(*Munich a Healthy Town*).

Recently, Pfeiffer and Eisenlohr investigated the incidence of typhoid in certain districts during the years 1888-1892, with the aid of the lists of notification of the disease. They examined 665 houses, in which there were 831 cases; and found that 69.9 per cent. of the houses, with 70.5 of the typhoid patients, had been served exclusively with the highland water-supply.—(*Archiv f. Hyg.*, Bd. xvii: 1893.)

Conclusions.

Taking all the above facts into consideration, it must be admitted that the evidence is very strongly in favour of the conclusion that,—whilst the great decrease of typhoid in Munich has been due in a general way to improved sanitary conditions, and possibly in some measure to decreased pollution of the water,—

(1) the drinking-water has not played an important part in producing and reducing the typhoid-epidemics in Munich;

(2) the great prevalence of typhoid in Munich was due to the great pollution of the soil (including specific pollution), modified by certain unknown conditions in the soil which are correlated with the movements of the subsoil water;

(3) the gradual reduction of the typhoid was due to the gradual purification of the soil; and the abrupt termination of the epidemics to the sudden removal of all the slaughter-houses.

In our own country the number of epidemics of typhoid fever which have been shown to be connected with the water-supply is so large that we have difficulty in understanding how it is possible that there was not a similar connection in Munich. It is difficult also to imagine the processes by which the typhoid virus is conveyed direct from the soil through the air into human beings, whereas the connection between the drinking water seems to be extremely simple and probable. An explanation of these apparent discrepancies may possibly be found in the extraordinary conditions of the soil and subsoil water of Munich.

Such conditions are not found on a large scale in this country. It is conceivable, for instance, that the typhoid virus may have been so far modified or destroyed by the time that it reached the great stream of subsoil water which flows underneath Munich, that it seldom or never caused infection amongst those who were drinking that subsoil-water. It is conceivable also that there are certain conditions of a soil owing to which typhoid infection may be conveyed through the air to those living on that soil, and that such conditions were pre-eminently prevalent in Munich, whilst they are limited and exceptional in this country. Our ignorance of the processes which the typhoid virus undergoes after leaving the patient forbids us to form absolute conclusions. It must be admitted that the custom has been too common in this country to look only for a polluted water-supply as the cause of outbreaks of typhoid fever, to make no further inquiry when such pollution has been proved, and to rest content with this evidence as a positive demontration of cause and effect. Much still remains to be learned from a study of comparative epidemiology, and from a consideration of the conditions of water-supply, soil, drainage, etc., of those parts of the globe where typhoid fever is pre-eminently prevalent—especially, for instance, in India. From such a study we may reasonably hope to learn much that will explain the obscure cases of outbreak of typhoid fever, the sporadic and recurrent cases; and, again, those in which the infection cannot be traced to the water-supply.

Suggestions.

(1) That the history of typhoid fever in Munich indicates that the conditions of soil near and underneath houses may be an important factor in the production of typhoid fever; and that, in tracing out the causes of an epidemic, the conditions of the soil should not be overlooked;

(2) that the pollution of the soil with human and other organic refuse, and, in addition, with typhoid virus, may be the cause of some of the inexplicable cases of sporadic or of recurrent outbreaks, and even of some outbreaks which have been too hastily attributed to polluted water or some other cause;

(3) that it is very desirable to promote and extend experiments such as those of Professor Sidney Martin and others, for the study of the life-history of the typhoid bacillus in the soil;

(4) that the establishment of an international epidemiological association, and the study of comparative epidemiology, would be of the greatest service, and would probably help to throw much light on the still obscure and complicated problems involved in the study of the causes of typhoid fever and other similar diseases.

In conclusion, I am glad to have this opportunity of recording my sincere gratitude to the many kind friends in Munich who have spared no pains in helping me to investigate this very interesting history; and of congratulating them upon the splendid results which they have achieved, through which their city—once terribly afflicted by typhoid fever—has become more free from that disease than almost any other city in the world.

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THE RELATION OF VARIATIONS IN THE LEVEL OF THE GROUND-WATER

TO THE

INCIDENCE AND SEASONAL DISTRIBUTION OF MALARIAL FEVERS IN INDIA.

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(*Read: February 18th*, 1898.)

Various statements are to be found in the literature of malaria with regard to the influence of rainfall, moisture in the air, and variations of temperature on the occurrence of fever, but very little on the influence of variations of the ground-water. Some observations were, indeed, made by Drs. T. R. Lewis and D. D. Cunningham on this point in India, but the data they collected were from measurements by many different observers, and do not appear to have been made sufficiently regularly, or for long enough a time to allow of any very definite conclusions being based on them.

Waterlogging of a soil by a constantly high ground-water is too well-known a cause of malaria to need more than a passing reference. It is rather in dry places that observations are required, and it is chiefly this side of the question that will be dealt with in the present paper.

The rainfall is to some extent an index of the variations of the ground-water level, but only partly so. As is well shown in the charts in Davidson's *Diseases of Warm Climates*, the maximum fever rate may occur slightly before, with, or after the maximum rainy season; but I shall hope to show that the differences in this respect depend largely on the distance of the ground-water from the surface before the rainy season begins. Professor Lane Notter, in his well-known book on Hygiene, correctly remarks that: "The development of malaria may be connected either with a rise or fall of the ground-water." Hirsch, in his *Geographical Pathology*, writes: "In the most intensely malarious spots of the tropics, the prevalence of the disease is generally associated in a most marked manner with the

rainy season. The fever makes its appearance with the commencement of the rains, and last the whole period. If the rainfall be not excessive, it reaches a maximum usually when the rain ceases, and continues with decreasing extent and virulence until the setting in of the cold season." This again is generally true, but with considerable variations in different places; and these variations, I believe, depend chiefly on the depth of the ground-water level, and also to some extent on the nature of the soil, especially in relation to its power of retaining moisture.

It is more especially in countries where there is an absence of marshy or waterlogged soil that our knowledge of the factors which influence the occurrence and distribution of malarial fevers is defective. Chota Nagpur is mentioned by Hirsch as one of the exceptional places where malarial fevers prevail on a dry soil in the absence of marsh or waterlogging.

In 1895 I commenced a series of observations for the purpose of trying to ascertain the causes which influenced the seasonal incidence of malarial fevers in the dry district of Chota Nagpur. My observations were made in Doranda, the cantonment of Ranchi, which is the headquarters of the district. This place is situated on a dry porous soil, and is 2,000 ft. above the sea level, and my observations were made on some four hundred men of the 11th Bengal Infantry, who all lived in lines on a small area of ground. Records were made of the maximum, minimum, and ground temperatures (the latter at a depth of 6 ft.), the rainfall, the moisture in the air, and lastly the level of the water in three wells which immediately surrounded the lines, taken twice a week by means of a float attached to a metallic tape. The average of the distance of the water from the surface of the ground in the three wells was taken to give the level of the ground-water beneath the lines in which the men were living. Notes were taken in shorthand of each man who came to hospital with fever, and the day on which he first began to suffer from it was noted. The blood of the majority of the cases was examined for the malarial organism, and its frequent discovery, together with the precisely similar character of the symptoms in all the cases, proved that they were really malarial in their nature.

The fever season in this place is the rainy season, which lasts from the middle of June to the middle of October, as a rule, but varies somewhat in different years. More than

80 per cent. of the yearly fever occurs at this time. During the cold weather, and the hot dry months, there is very little fever, and during these months the ground-water level was from 25 ft. to 35 ft. beneath the surface in these lines.

In 1895 the rainy season began about the middle of June, and during the latter half of this month very nearly 10 ins. of rain fell. The air, from being very dry, became saturated with moisture, the temperature fell some 15° and varied very rapidly, falls of 25° having been registered within a few hours. In short, all the atmospheric conditions were altered, but there was no increase in the fever-rate over that of the previous dry hot month of June. The water-level only had not materially changed, that is to say, it had only risen from 35 ft. to 28 ft. from the surface, being still too low to affect the fever-rate.

The subsequent course of the fever and ground-water variations are shown in the accompanying chart (No. I). The upper curve shows the variations in the level of the ground-water in three and four day periods, while the lower curve illustrates the variations in the daily average number of fresh cases of fever in the same periods. Below is given the rainfall in inches. It will be seen that from the 4th to the 13th of July there was a very heavy rainfall, and the water level rose from 28 ft. to 16·5 ft. from the surface. At the same time the fever-rate first began to rise, so that the daily average of fresh cases was 2·16, or fifteen cases in the week, instead of only six cases in the whole of the previous month. Then there was a slight break in the rains, and the water fell 7 ins. in the next period, which is practically only a cessation in its rise, but immediately the fever-rate fell to one case a day. Then the water rose rapidly once more, and with it the fever-rate increased up to 2·5 cases a day, only to decline again with the next fall in the water-level, during the first week in August. Once more the water rose until it was only $5\frac{1}{4}$ ft. below the surface of the ground on August 18th—that is, a total rise of nearly 30 ft. in eight weeks—and again the fever rose until the average daily number of cases reached three, the highest rate for the whole year. During the next month there was but little rainfall. and both the curves steadily declined. In the third week of September, however, there was a fall of 5 ins. in two days; the water-level once more rose, and was again accompanied by a rise in the fever-rate. After this the rains practically ceased and the water fell steadily, with the exception of a very slight rise

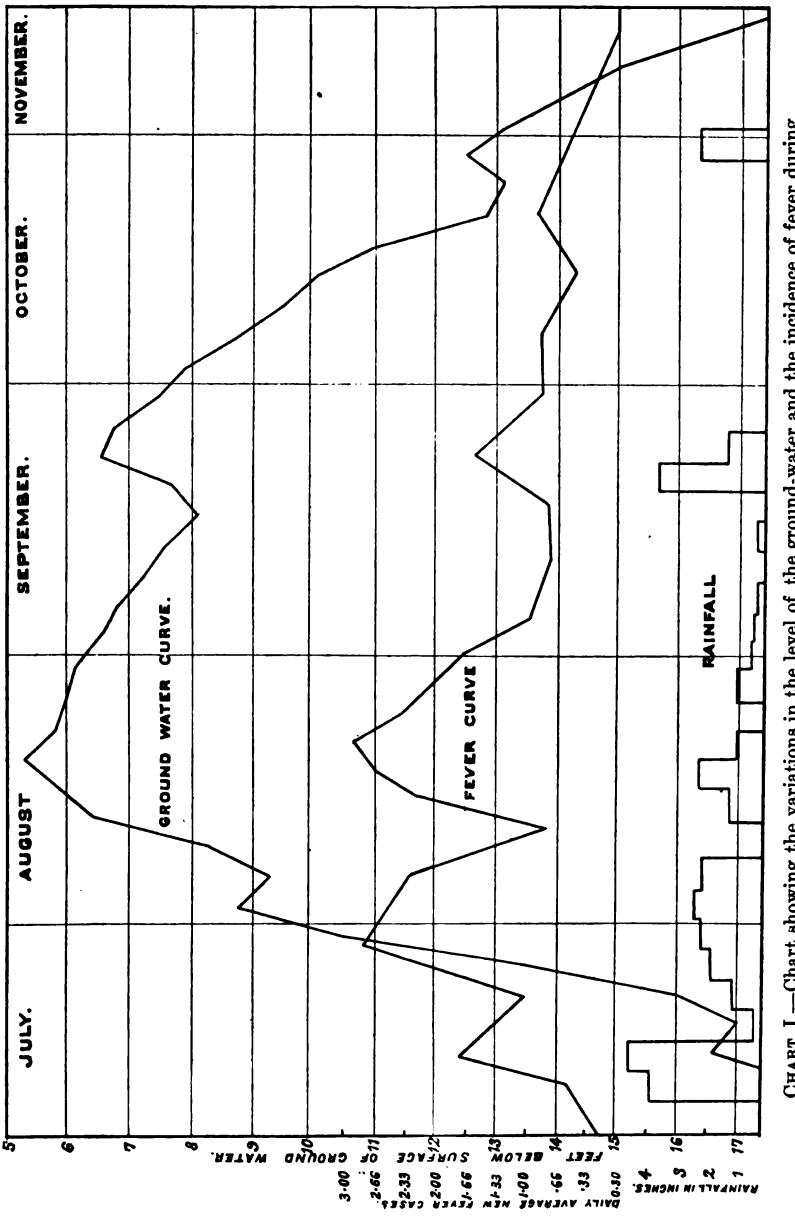

CHART I.—Chart showing the variations in the level of the ground-water and the incidence of fever during four months at Chota Nagpur.

when it was 13 ft. from the surface, which was apparently too small to influence the fever; and when it had receded to 17 ft. the fever ceased. During the next year observations were taken for me in the same manner by Surgeon-Lieutenant Wilson of the I.M.S., and a very similar chart was obtained, which I regret I am unable to show you to-night, as, unfortunately, I left it behind in India; but I have obtained further confirmation of the relationship between the rise and fall of the water and that of the fever in some tea gardens in Assam, which I shall come to very shortly.

I must first, however, explain this other chart (No. II), which illustrates the monthly fever-rate and the monthly rainfall over a series of ten consecutive years in the same place, and among the men of the several regiments who successively lived in the same spot. The first and third lines illustrate the fever-rate, while the second and lowest show the rainfall. The general relationship between the two will be at once apparent, while a closer study reveals several points of interest. In the first place, it will be observed that while the rains usually begin in the month of June, the fever does not increase to any extent until a month later. This is due to the fact, already mentioned, that the water is always some 35 ft. from the surface of the ground at the commencement of the rainy season (and was still 28 ft. down at the end of June in 1895, although 10 ins. of rain had fallen), so that it is not until there has been heavy rain in July on the top of that of June, that the ground-water rises high enough to influence the fever-rate.

Secondly, it will be noted that in the years of exceptionally heavy rain, such as in 1887, 1894 and 1895, the fever is also unusually great; while in the years 1890, 1891 and 1892, when the rainfall was deficient, the fever-rate was also very low. But, in addition to the absolute amount of the rainfall, the regularity or otherwise of its distribution exercises an important influence on the rapidity and extent of the variations of the ground-water, and so on the amount of fever. Again, the amount of the rainfall in the seven months preceding the regular rainy season will have some effect, in so far as it influences the level of the water at the beginning of the rainy season; for if it be then higher than normal, a given quantity of rain will have a greater effect in raising the water level near to the surface of the ground. All these factors, however, act by causing a greater or less variation in the water level, and all the

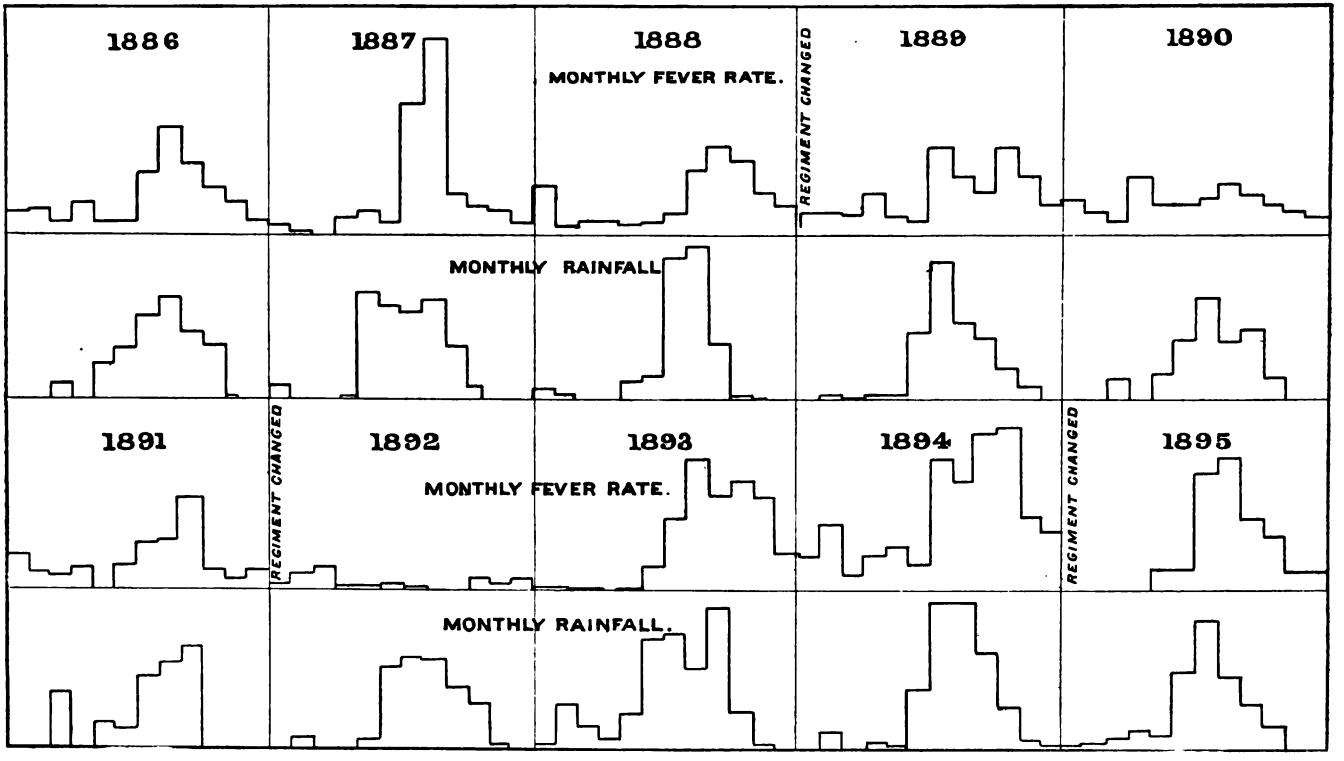

CHART II.—Chart illustrating the monthly fever-rate and the monthly rainfall over a series of ten consecutive years at Chota Nagpur.

differences in the amount and distribution of the fever in the years illustrated in the chart can be explained by the combination of these various factors in different degrees. Thus in the years 1886 and 1895 both the rainfall and fever rate were average ones. In 1887, both the rainfall and fever rate were heavy; but the former began very early, namely in May, and, for the reasons already given, the fever did not increase until July. On the other hand, the rains ceased very early, there being unusually little in September, and the fever season was also a short one. In 1889 the rainfall was unevenly distributed, but its total quantity was not large, and the fever was about the average. In 1890 and 1891 both the rainfall and fever rate were low. In 1892 there was a remarkable absence of the usual increase in the fever during the rainy season, which at first sight seems to form an exception to the rule which I am illustrating, but, on looking a little more closely, it will be found to form a true example of the maxim that it is the exception which proves the rule. Thus, in the first place, it may be pointed out that there was exceptionally little rain in the early months of the year, while the rains of the previous year had both been deficient and had ceased very early, there being no rain whatever in October: a most unusual occurence. Then the rainfall of 1892 was below the average; and, thirdly, it was most evenly distributed in the different months, so that less than 12 ins. fell in any one month. The water-level must, therefore, have been very low at the beginning of the rainy season of this year, and the rains when they came were both deficient and very evenly distributed; so that it is obvious that all the factors which make for a low and constant ground-water level were present during this year; and it is certain that of the whole ten years the water must have remained further from the surface of the ground, and have varied less in this than in any other year of the series.

In 1893 the rainfall was very heavy, and the fever rate proportionately so; while in 1894 we have the precisely opposite characters to those of 1892, namely, both a very heavy and a very unevenly distributed rainfall, over 19 ins. having fallen in both July and August. The consequence was that in this year there was the highest fever rate of any, the water-level having risen so high that it flowed out of the mouth of one of the wells. It may then be said that these charts confirm the previous one in proving that, in this particular place, the amount of fever varies in proportion to the amplitude of the variations of the ground-

water level, and the first chart points to the relationship of the rise and fall of the ground-water level to the increase and decrease of the incidence of the fever being so definite and constant that the two must be casually connected.

The amount and distribution of such fever as occurs in the dry first half of the year remains to be explained. That the small rainfall of this period does not influence it, is seen from the fact that in the first half of 1893 there was more rain than usual but very little fever; while, on the other hand, in the same months of 1889 there was very little rain but a good deal of fever. Nor would it be expected that there should be a relationship between the two at this time, for the water-level is always from 25 to 35 ft. down during these months. If, however, the amount of fever in the early dry months of one year be compared with that of the previous rainy season, it will be found that the two are in proportion. For example, there was more fever than usual in the early part of the years 1888 and 1894, in correspondence with the high fever rate of the preceding years. On the other hand, there was very little fever in the early part of the years 1891 and 1893, in relation to the low rate of the two previous rainy seasons. The years 1889 and 1895 are apparent exceptions; but once more they are of the kind which prove the rule: for in these two years, as well as in 1892, a new regiment came to the station early in January, and the following figures show that the amount of fever that they suffered from in the early part of the years mentioned was in proportion to the fever rate among them in their previous station, even when that was in a different province.

Regiment.	Reached Doranda.	Previous Stations.	Former Fever-rate.	Fever, Doranda.
VIII B. I.	January 1889	Barrackpore and Chittagong	480 per 1,000	58
XII B. I.	January 1892	Benares ...	267.1 per 1,000	20
XI B. I.	January 1895	Bareilly ...	116.3 per 1,000	9

The obvious explanation of these facts is that the cases which occur at the time of the year when the water-level is low are relapses from among those men who were attacked during the preceding rainy season. This I found was actually the case in the early part of 1896, in Doranda: for although only 25 per cent. of the men of the regiment

suffered from fever in the rainy season of 1895, yet more than three-quarters of those who had it in the early months of 1886 had suffered from it in the previous rainy season, and many of them had had more than one relapse.

The incidence of malarial fevers at this spot at different seasons of the year has, then, been satisfactorily explained; but before passing on to my observations in other places, I must mention the important fact that, at the very time that the ground-water had risen to within 5 ft. of the surface of the ground in the lines occupied by the regiment under observation, it was 25 ft. down only 200 yards away, and its great rise under the lines was doubtless due to the fact that there was a road along one side of the area, which materially interfered with the flow of surface water from it. I have no doubt in my own mind that, had the lines been situated on the ground where the water always remained 25 ft. or more from the surface, there would always have been as little fever among the regiment as there was in the exceptionally dry year 1892. At my suggestion it was proposed to drain the lines more efficiently, but for financial reasons it had not been carried out when I last heard from the medical officer of the station, so I cannot report the result of this measure. This fact (and I have had similar experiences in other places) is of great importance in proving how very local are the conditions which influence the occurrence of malarial fevers; but I shall discuss this point more fully after I have given another instance of it presently.

Now the instance which I have just given of the distribution of the fever in Doranda is at one extreme end of the scale, namely, that of a very dry soil accompanied by a water-level which is very low during the greater part of the year, but rises very rapidly during the rainy season. The other extreme is seen in many of the districts of lower Bengal, which form part of the great delta of the Ganges and Brahmaputra rivers. The greater part of these districts are under water during the rainy season, and at this time the fever is at a minimum. When the rains have ceased, however, and the saturated ground begins to dry up again, the fever season attains its maximum. Moreover, the ground-water is within a few feet of the surface throughout the year, and malarial fevers prevail to a considerable extent in every month of the year, being much more evenly distributed than in Doranda and other similarly situated places. In this case of the flooded districts, the maximum fever rate occurs during the drying-up of the saturated

soil, doubtless owing to the rapid evaporation of moisture from the ground carrying up the malarial organisms into the air, when they are breathed in by the inhabitants on or near the drying-up ground. Moreover, the ground-water is always sufficiently near the surface to allow of evaporation going on in the same way throughout the year, although to a less extent than just after the floods have subsided; and so fever is constantly present to a considerable extent, and is never absent for long periods, as in places where the ground-water rapidly recedes at the end of the rainy season. This also accounts for the fact which I have observed, namely, that malarial cachexia is much more common in these waterlogged places than in the dry ones with low water-level; because, in the former, frequent re-infections may take place in the same persons throughout the year; while, in the latter, there is little or no infection except during the four months' rainy season, and although relapses may occur, they usually cease long before the next rainy season ensues, and so complete recovery takes place before re-infection is likely to occur.

Between the two extremes, of the very dry places with a low and varying ground-water, in which, I believe, infection takes place by the malarial germs being carried up by the air which is displaced by the rising ground-water, as in Doranda, on the one hand; and the waterlogged and sometimes flooded regions of the Gangetic delta, where the infection takes place by the organisms being carried up into the air by evaporation of moisture from the soil, on the other hand, there are intermediate places in which both factors play a part in influencing the distribution of the fever. These places are, in fact, by far the most common, and also present the most complicated problem: for it is obvious that the two factors may be present in ever-varying proportion, while the denseness or otherwise of the soil will play an important part in influencing the amount of moisture which it will retain, and the rapidity and extent of the evaporation which takes place from it.

During a year which I spent in Assam investigating the epidemic malarial fever of that province, which is locally known under the name of Kala-azar, records of the variations of the ground-water were being taken for me in the different districts by the Government, while I was also able to study the incidence of malarial fevers in relation to the variations of the ground-water in the coolie lines of several tea gardens, through the kindness of Drs. Dodds Price and Lavertine, tea garden practitioners in the Now-

gong district. The data were not quite so accurate as those which I obtained in Doranda, as the exact day on which a coolie came to hospital after getting fever was, to some degree, dependent on his chances of making extra pay, etc. However, ample evidence was obtained to show that in those places where the water was some considerable distance from the surface before the rainy season commenced, the fever rate rose and fell with the rises and falls of the ground-water, just as it did in Doranda, but as the water was in no case so far down to commence with in the Assam instances as in Doranda, the fever rate increased during the first month of the rainy season, as the water quickly rose sufficiently to influence it. That this rise was due to the variations of the ground-water, and not to other causes, such as changes in the temperature, etc., was proved by the fact that in one instance, in the case of two coolie lines situated only some three hundred yards apart, and in other respects similarly placed, there were three rises of both the water-level and of the fever rate in one of them, while in the same period of time there were only two rises of both in the other line.

Again, it was found that there was most fever in proportion to the number of inhabitants in those lines beneath which there was the greatest and most rapid variations of the ground-water, and least in those in which it was most constant in its level. To give an example: In a certain tea garden there were three coolie lines side by side, but separated from each other by a narrow lake between the upper and middle lines, and by a deep depression between the middle and lowest line. Measurements of the water-level in the wells of each line were taken for me twice a week, and the fever rates in the three lines recorded. During the month of July a lot of rain fell, and there was a corresponding rise of the ground-water, and an increase in the prevalence of malarial fever. The three lines, however, differed considerably in both the amplitude of the variations in the water-level, and in the number of cases of fever in proportion to the number of inhabitants of the respective lines. Thus the upper line was situated on ground which was some 10 ft. higher than the other two, which were on just the same level. In this upper line the water varied during this month from 21 ft. to 12 ft. 8 ins. from the surface of the ground, and the fever was less than in either of the other lines. In the lowest line it varied from 22 ft. to 8 ft. 7 ins. from the surface, and the fever rate was somewhat higher than in the first line. In the

middle line measurements were taken of three wells, two of which were situated within a few yards of the edge of the tank, while the third was 50 yards from it. In the first two the water rose from an average of 14 ft. to one of 4 ft. 6 in., while the third varied from 15 ft. to 8 ft., clearly showing the influence of the tank in raising the level of the ground-water beneath these lines, and especially of the part nearest to it. It will also be noted that the water rose nearer the surface in this line than it did in either of the others, and in accordance with this the fever rate was two-fifths greater in this line than in either of the others. On my recommendation it was decided to lower the water in this tank by some 8 ft. or 10 ft., but I have not yet heard the result of the measure, although it could hardly have been otherwise than a favourable one. This, of course, is but an instance of a well-known law, but the accuracy of the data and the very localised variation of the fever rate in accordance with that of the water-level, lend some interest to it.

It was also found that in places where the ground-water was at an intermediate distance from the surface before the onset of the rains, say from 15 ft. to 25 ft., and the soil was a heavy one, which retained a good deal of moisture, then there would first be a rise in the fever-rate with the rise of the water, and a fall with the ensuing fall of the water; but if there was then a slight break in the rains, and the water-level continued to fall slowly from evaporation of the ground-water which was still only some 10 ft. or 15 ft. down, there would be another rise in the fever rate, just as occurs when flooded ground is drying up. Here we have an instance of the two factors successively acting in the same place. The chart (No. III) which I now pass round illustrates this point fairly well. It will be noticed that there were great and rapid variations in the water-level here, and that corresponding with them, only often a few days later, owing to the incubation period of the fever, there were rises in the fever-rate. Further, during the break in the rains corresponding to the slow fall of the ground-water between the 21st and 31st of July, and again during the final steady fall at the end of the rains from the 9th of October to the 3rd of November, there are rises of fever corresponding to the times when evaporation from the heavy moist soil would have been taking place. The irregularity at the end of the curve is partly due to the complication of relapses, which are most frequent at the latter part of the fever season. It is worthy of note that the

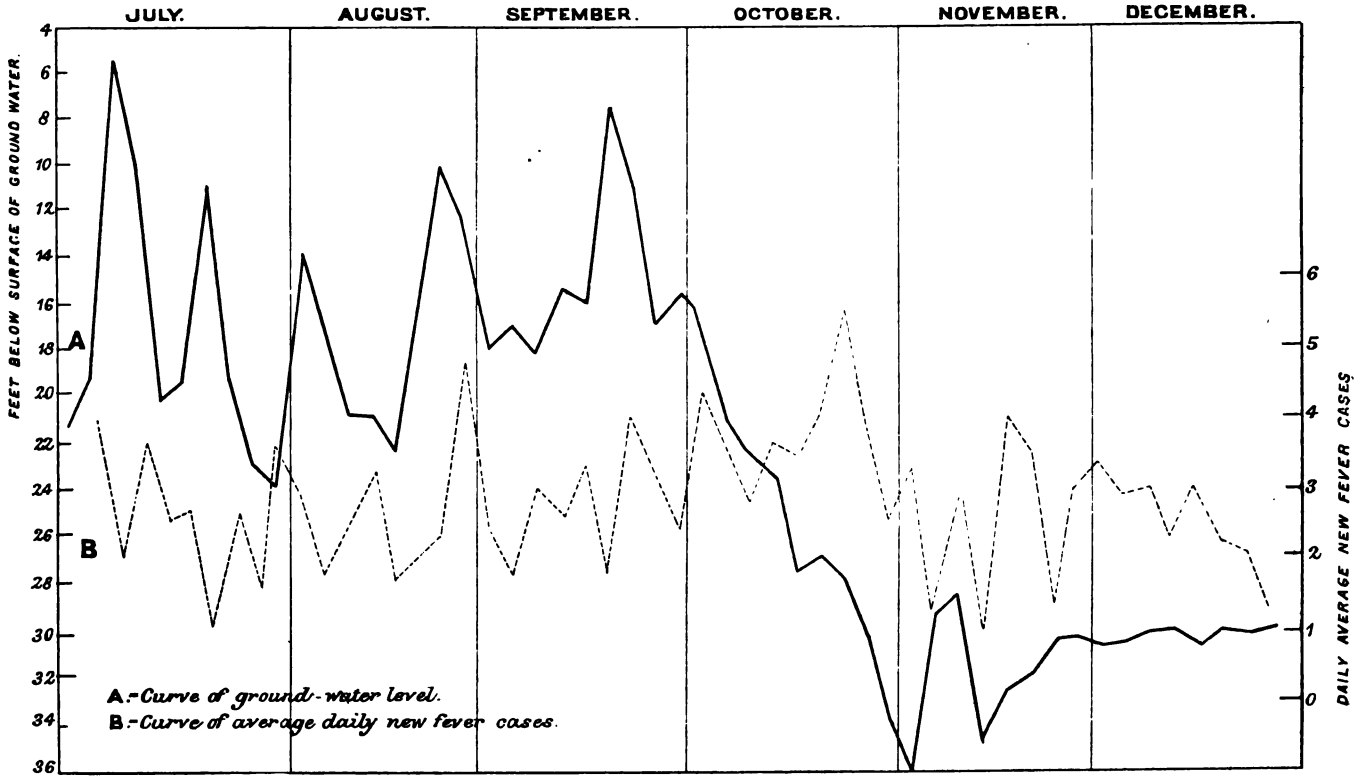

CHART III.—Chart illustrating the relation of fever-incidence (Kala-azar) to ground-water in an Assam tea-garden.

garden on which these levels were taken is situated at the foot of some low hills, and is a miniature example of the conditions which obtain in terai regions, such as the foot of the Himalaya mountains, and I would suggest that the notorious unhealthiness of such regions is probably due to the extremely rapid and great variations in the water-level in those parts. A curious example of an apparent exception to the rule that the foot of high hills is very malarious, which I met with in Assam, lends some support to this view. In the north of the Mangaldai district, immediately at the foot of the Himalaya mountains, are situated some tea gardens which are remarkably free from fever. On inquiry, I found that all the streams from the mountains in this place disappear at the foot of the hills into a sandy soil, and appear again along a line just beyond these gardens. They evidently run into a subterranean basin, which must keep at a nearly constant level; and in one of the lines situate within this area it was found that the level of the ground-water as measured in the wells varied very little, and this fact accounted for the absence of the amount of fever which might have been expected in such a terai region.

The next chart (No. IV) which I have to show you illustrates the ground-water and fever curves on a garden situated only some twenty miles from that of the last chart, but it presents just the opposite characters. The upper line represented the water-level, and it will be seen that it was remarkably constant, only having varied between 5 ft. and 10 ft. from the surface. The fever also varies much less than in the previous chart, and although there is a rise with the main rise of the water-level, yet the greater part of the fever occurs during the drying up at the end of the rainy season, when the water is slowly sinking. Here, then, the main factor is the evaporation from the saturated soil during the drying up.

In Dibrugarh, which is the most easterly part of Assam, the water-level varies between 20 ft. in the dry cold weather to 5 ft. from the surface in the middle of the rainy season, the annual rainfall averaging about 100 ins. The fever increases with the rise of the water, but is also high when the soil is drying up after the rains are over; the fall of the ground-water being slow and steady at this time, both factors again coming into play at different parts of the year.

In the Punjaub the fever occurs mostly after the rains, but I have no observations on the ground-water level here,

except in Bunnu on the frontier. In this place the water is more than 50 ft. from the surface even in the rainy

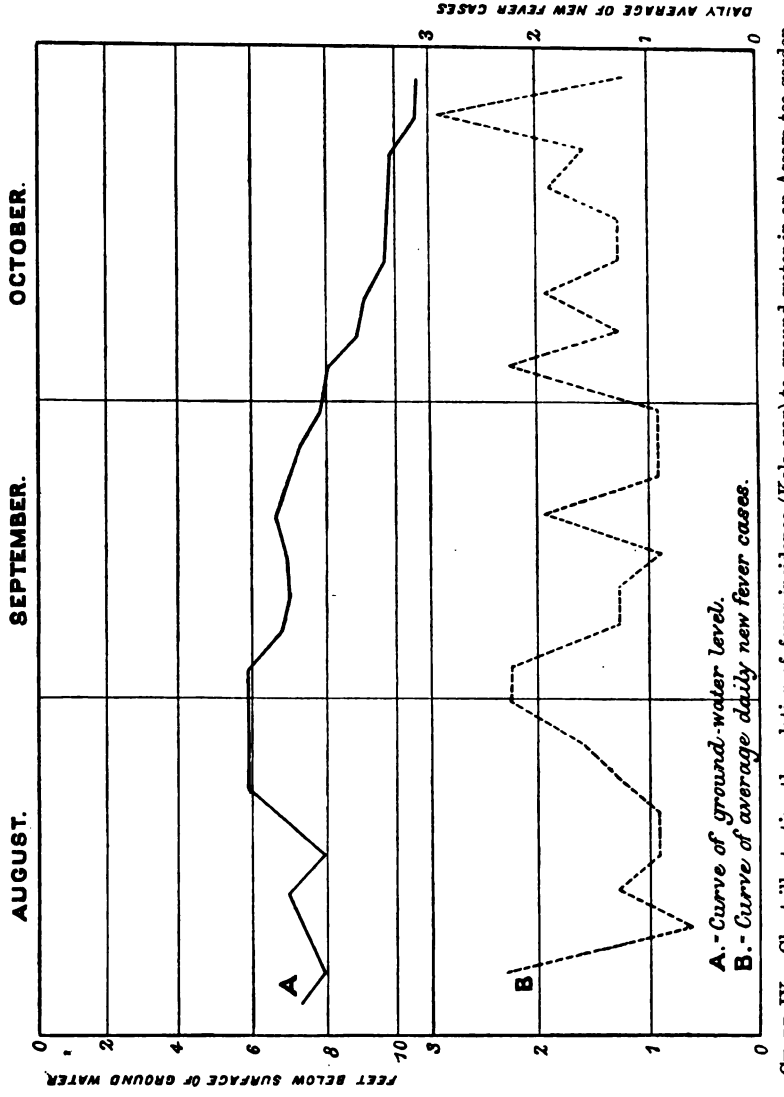

CHART IV.—Chart illustrating the relation of fever-incidence (Kala-azar) to ground-water in an Assam tea-garden.

season, but it must be remembered that there are no regular rains here. The whole place is, however, irrigated, and fever is often seen when fields which have just been

irrigated are drying up. Most of the fever occurs on the beginning of the cold weather, when there are great falls in the temperature at night, and is commonest in those who sleep out in the open air and so get chills. This is probably due to such chills coming at just the very time when the system is at its lowest daily ebb, allowing any *plasmodia malariæ* which may gain access to the body successfully running the gauntlet of the white blood corpuscles.

So much for the facts that I have to bring before you this evening. I have already mentioned that I believe that the incidence and seasonal distribution of malarial fevers in most places of India can be explained by taking into account both the rainfall and the variations of the ground-water level. Such cases as that of Doranda—in which the entire distribution of malarial fever is dependent on the organisms being carried up into the air by the piston-like action of the rapidly rising ground-water, and where the factor of their being carried up by evaporation plays little, if any, part—only occur in places situated on a rapidly-drying and porous soil, accompanied by a ground-water which is very low for the great part of the year, but varies rapidly during the rainy season. This rapid variation of the ground-water level is of great importance in explaining the occurrence of fever in dry places where there is no marshy ground. It also enters largely into the causation of fever in places with an intermediate and varying ground-water, and has least influence in places with a constantly high ground-water, in which the factor of evaporation plays by far the largest part.

There are two other points which I wish to refer to, which are of considerable importance, both from the practical and the theoretical standpoints. They are, firstly, the strictly localised action of the variations in the ground-water level; and, secondly, the light which their discovery throws on the manner in which the infection of malarial fever takes place.

Instances of the former have been given both in the case of Doranda, and in that of the variations in the fever rate in the three parallel tea garden lines. In the first instance, there was very little in the conformation of the ground to suggest the great difference in the variations of the ground-water in the areas which were but some 200 yards apart, and the surface levels of which did not differ by more than 3 ft. or 4 ft. Yet in the one spot the water rose to within

5 ft. of the surface, while in the other it remained 25 ft. down. It is well known that sites for camps and cantonments, which have been selected by medical officers as the most suitable, have had to be subsequently abandoned owing to their proving to be very malarious. I would suggest that before choosing between two or more apparently favourable sites, if a well were first sunk, and the variations of the water-level recorded during the rainy season—or, better, for a whole year—it would be found that the one in which the water-level was lowest and varied least would prove to be the least malarious; and it is possible that large sums which have before now been spent in building barracks, which have afterwards had to be abandoned on account of their unhealthiness, might be saved. Again, such measurements may point to deficiency of surface drainage which was not previously apparent, as was the case in the Doranda lines and the tea garden tank, the remedying of which might prevent much fever.

Secondly, it is evident from the two instances just referred to, that the infection arose from the very ground on which the houses of the regiment, and of the coolies respectively, were built. There is no necessity or reason to suppose that the infection was carried by mosquitoes, or any other such medium. The first chart that I have shown can only be explained on the hypothesis that the rise of the ground-water displaces the air from the interstices of the soil, and causes the malarial organisms, which live in the earth, to be carried up into the atmosphere, when they are breathed in by the persons living over the affected ground. The infection probably takes place chiefly during the night, when the powers of resistance will be lowest. In the case of drying-up ground or marsh, again, the infection will be through the air; and I am of the opinion that this mode of infection in malaria is the general one, although it is undoubtedly true that the disease may also be conveyed through water. The fact that all the water in many of the gaols of the Punjaub was for several years boiled without any diminution of the prevalence of malarial fevers, also points very strongly to infection through the air being far more common than that through water, while all the facts already given point in the same direction. Any malarial organisms which may be breathed into the lungs have only a very thin layer of tissue to traverse in order to obtain access to the blood, where they live and multiply. It has recently been strongly urged, especially by Dr. Patrick Manson, that these organisms must in some way escape

from the body to pass through an extra-corporeal part of their life-cycle. This is very probable, although in the case of ordinary malarial fevers it is equally possible that the germs, which are so widely distributed, may have a complete existence outside the body, and are, so to speak, only facultatively parasitic.

In the case, however, of the epidemic communicable forms of malarial fever (such as I have recently shown the Assam disease, locally known as under the name of Kala-azar, to be), it is quite certain that the *plasmodium malariæ* must in some way escape from the body of one person and gain access to that of another, either directly through the air, or—as I think is more frequently the case—after going through the soil. In this way only can be explained the manner in which a man contracts the fever while living in an infected village, and, after returning to his own uninfected village, while still suffering from the fever, members of his household first get it, and afterwards others in the village are affected. I will not dilate on this point further in this paper, as I shall be reading one on this epidemic malarial fever before the Medico-Chirurgical Society very shortly, but wish to suggest a possible method of infection in malarial fevers, which will explain all the facts that I am acquainted with. It is this: If malarial fever may be contracted by breathing in the malarial organisms, why should they not be also breathed out again when they have completed their work in the body? They have only to pass back again into the alveoli of the lungs, and they will be able to escape from these organs more easily than they entered, for the cilia of the air passages will assist their exit. This simple theory seems to me to be much more likely than the elaborate mosquito theory, which is largely based on an analogy between such widely different constituents of the animal scale as the *plasmodium malariæ* and the *filaria sanguinis hominis;* while it is also, I think, more in consonance with the known facts as to the incidence and seasonable distribution of malarial fevers.

However this may be, it is rather the more practical points of the very frequent dependence of malarial fevers on purely local and often removable variations of the ground-water level on which I chiefly wish to lay stress in this paper, and I hope that the evidence I have adduced will afford material for an interesting discussion.

ON AN OUTBREAK OF MILK-BORNE ENTERIC FEVER IN CLIFTON,

IN RELATION TO DISTRIBUTION OF THE DISEASE, INCIDENCE OF ATTACK, AND GENERAL CHARACTER OF THE OUTBREAK;

WITH SOME REFERENCE TO THE USE OF THE SERUM TEST (WIDAL) IN PUBLIC HEALTH WORK.

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Medical Officer of Health of the City of Bristol.

(*Read: March 18th*, 1898.)

The City of Bristol contained, at the time this outbreak befell, a population estimated at 232,242, which the recent Extension Bill has increased to 316,900.

Clifton contains a population estimated at 47,553, and is a Registration Sub-District of Bristol.

The records of the ten previous years show that, during this period, the Enteric Fever rates for Clifton and Bristol have not been in excess. The rates for Clifton show, as would be expected in a small district, a wider annual fluctuation than those derived from the much larger population of Bristol, but the rates for both are year by year consistently below those for the thirty-three large towns, and for England and Wales.

FEVER.

Death-Rates per 100,000 *Living.*

—	England and Wales.	Bristol.	Clifton.	Thirty-three large Towns.
1887	18	12	7	22
1888	17	13	3	20
1889	17	16	17	20
1890	17	15	10	19
1891	16	10	3	20
1892	13	8	6	15
1893	22	11	20	24
1894	15	10	3	19
1895	18	9	0	20
1896	17	8	16	19
Average of 10 years ...	17	11.2	8.5	19.8

Bill 18-79

Table Showing Notifications of Enteric Fever in Bristol and Clifton for the Fifty-Two Weeks of 1897.

—	Enteric Fever: Notifications.		Diarrhœa: Deaths.	
	Clifton, Pop. 47,553.	Bristol (excluding Clifton), Pop. 184,689.	Clifton, Pop. 47,553.	Bristol (excluding Clifton), Pop. 184,689.
1	—	—	1	1
2	—	2	—	2
3	—	—	—	1
4	—	1	—	—
5	—	3	—	—
6	—	3	—	1
7	—	—	—	1
8	—	2	—	1
9	—	1	—	—
10	—	—	—	2
11	—	2	—	1
12	2	3	1	2
13	—	1	—	1
14	1	1	—	1
15	—	1	—	—
16	—	1	—	—
17	—	—	—	—
18	1	—	—	—
19	1	1	—	1
20	1	1	—	1
21	1	1	—	1
22	—	1	1	—
23	1	—	—	—
24	1	1	—	—
25	—	—	—	2
26	1	1	—	2
27	—	1	—	1
28	—	4	—	1
29	—	1	—	4
30	—	—	—	5
31	1	6	1	11
32	—	—	—	9
33	1	2	2	26
34	—	1	—	17
35	—	5	—	12
36	—	5	—	8
37	1	3	—	4
38	1	3	—	6
39	—	3	—	4
40	—	—	—	1
41	3	3	—	4
42	16	2	—	2
43	100	9	—	—
44	60	6	—	2
45	19	9	—	2
46	9	6	—	—
47	2	2	—	—
48	2	3	—	1
49	2	3	—	2
50	3	5	—	2
51	—	—	—	—
52	1	3	—	—

The fever rate for 1897 in England and Wales is given me by the Registrar-General as 16.0, and that for the thirty-three large towns is 18.0. The rate for Bristol during this year has risen to 20.2, and that for Clifton to 58.8 per 100,000 living. This enormous increase in Clifton was due to the outbreak of Enteric Fever which arose towards the end of September.

It will be seen from the Table on page 79, that 216 cases were notified in Clifton between the 40th and 50th week. But 28 cases notified in other districts of Bristol were found to have contracted infection in Clifton (domestic servants, etc.), and are therefore included in the 244 cases of the outbreak. This only leaves 20 cases as originating during these ten weeks in all other districts of the city. The absence of fatal diarrhœa from Clifton is notable.

No such outbreak has been known in the city since 1878, when 131 cases occurred in Redland amongst the customers of one particular dairy farm, at which a patient convalescent from Enteric Fever had gone to reside, and where the conditions permitted specific pollution of the well.

During the year 1897 the notifications in Clifton of Enteric Fever had not, up to October, exceeded four in any one month; and in September the only two cases notified were in two sons of physicians who had contracted the disease during the autumn holiday, one in France and the other in Devonshire. A visitor from Maidstone was notified with this disease on the 11th October, and as these were the only cases recognised up to this date in Clifton, there was no reason for alarm, or even suspicion. The cases of Enteric Fever in the rest of the city of Bristol did not at any time during the year show material excess, and the figures for the year are well within the average. "Diarrhœa" was in some excess as a cause of death in Bristol compared with the average of the previous ten years, but the rate (0.65) was considerably below that for the thirty-three great towns (1.24). Clifton was singularly free from fatal diarrhœa during the autumn.

The cases of two children in the same family reported from the Children's Hospital on the 15th October, however, led to some definite inquiries as to home milk supply, which proved misleading, as a casual supply situated a few doors off, and the cause of the mischief, was not mentioned to us. On the 19th October samples of blood from three doubtful cases in Clifton were submitted to me for examination, all giving immediate positive results to the Widal reaction; and on the same date I received a letter concerning a

servant who had recently left service in Clifton, and developed Enteric Fever at her home in the Forest of Dean. Now, during October it had been currently reported that Influenza was very prevalent in Clifton, and that certain of the large schools were considerably affected; and it occurred to me that, as several of the Enteric Fever cases already brought to my notice presented very indefinite features, which might in the earlier stages have been mistaken for Influenza, it was possible that the so-called "Influenza" epidemic might prove to be Enteric Fever.

The serum blood test, as elaborated by Durham and applied to diagnostic purposes by Widal, had been brought under my notice in February, 1897, by Dr. George Parker, Assistant Physician to the General Hospital; and by the kindness of the physicians of the Hospital and Infirmary I had been able to make 29 observations, the results of which encouraged me to hope that the reaction might prove useful in elucidating a somewhat obscure outbreak. On the 21st October, therefore, I addressed a circular letter to every medical practitioner in Clifton, asking for blood samples from any doubtful cases. This met with an immediate response from the medical profession, who have throughout given me most ready and ungrudging assistance. By the evening of the 25th, after four days' steady work, I had examined, with Dr. Heaven's assistance, 41 specimens, 38 of which gave such definite and unmistakable reactions that I felt justified in assuming that they were cases of true Typhoid, especially as Dr. Klein confirmed my results in five instances, and as the post-mortem appearances of a clinically obscure case amongst them showed the typical intestinal lesions of Enteric Fever, and yielded a pure culture of the B. Typhoid from the spleen. Inquiries made at the invaded houses already pointed so definitely to certain milk supplies that I felt justified, on the morning of the 26th October, in absolutely prohibiting the circulation of milk from a particular farm, X.

This prohibition was carried out without resort to legal proceedings; the milk was daily brought into the city, and destroyed under supervision.

The evidence implicating this special supply has been already published in an interim report, and was communicated up to date to the Royal Medical and Chirurgical Society in November; but as subsequent inquiry has necessitated some slight modifications, which tend to further confirm the general conclusions, I will very briefly draw your attention to the facts as now known:—

1. The milk from the Farm X, situate in the County of Somerset, was consigned to a distributor A, whose man B met it on its entry into Clifton, over the Suspension Bridge, and distributed it directly from the churn to the customers without its going to any local dairy. Any milk not used on the round was, however, returned to the branch dairy, and sold to casual customers. Before the 26th September, when the big schools reopened, the supply was sufficient to serve two districts, A, the lower level, and B, the high level; but after this date the supply was confined to the high level district (see diagram). Some of the cases seem to have developed on the low level round at the beginning of October, while the incidence on the high level round was more marked in the second week of October.

On the low level round :— Ratio of attacks to houses.

27 houses were supplied
12 were attacked } 44.4 per cent.

31 cases resulted.

On the high level round :—

29 houses were supplied
19 were attacked } 65.5 per cent.

83 cases resulted.

Or taken together :—

56 houses were supplied
31 were attacked } 55.3 per cent.

114 cases resulted, or more than two cases per house.

The inmates of these houses numbered 453, so that 25.1 per cent. were attacked, or just a quarter of the whole number.

2. Milkman Y started with a pure supply from Ashton, in the County of Somerset, but at Bower Ashton he met the X cart, and occasionally took a supplementary supply from the churn consigned to Clifton; after receiving which he supplied milk, yielding two cases of Typhoid at Bower Ashton, proceeded to Leigh Woods, where six more cases appeared in three houses supplied, and then entered Clifton.

On his round in Clifton :— Ratio of attacks to houses.

40 houses were supplied
18 were attacked } 45.0 per cent.

48 cases resulted, or more than one case per house.

The inmates of these houses numbered 308, so that 15.5 per cent. were attacked, or about one-sixth.

3. The third and last supply known to be implicated (Z) came from a farm at Westbury, and entered the city from the North, at a point remote from the Suspension Bridge, over which supplies X and Y came. The milk from this

farm is distributed in Clifton on three rounds. Two of these rounds were entirely innocent of cases, and the third round was (with one exception, a servant who lived close to, and admits to frequently obtaining casual supplies from, the branch dairy to which unused X milk was returned) also innocent of cases up to a certain point, but beyond this point cases began to occur with marked frequency (see diagram).

On comparing the routes of the three dairymen, which we had plotted upon a map, it was at once discovered that, at the very corner where this change from freedom to infection occurred, Z's round met that of the X supply, in charge of the man B; and Z admitted that he was in the habit, when running short, of obtaining at this point supplementary supplies from B. After this, cases commenced at the very next house he supplied, and continued with considerable frequency along his route.

Before adding the X milk { 11 houses were supplied; 1 house attacked } 9.0 per cent.
1 case resulted (obtaining casual supplies from X shop).

After adding the X milk { 16 houses were supplied; 8 were attacked; 22 cases resulted. } 50.0 per cent.

In the aggregate we find, up to December 18th, the close of the outbreak :—

	Houses Attacked.	Cases.
On regular milk rounds	57	184
On regular rounds after October 17th	1	2
Obtaining casual supplies from shop to which X milk was returned	21	35
Obtaining milk from shop on low-level round supplied with X milk	6	9
		230
Houses attacked obtaining milk from dairymen not known to obtain infected supplies	13	14
	98	244

Thus 230 of the 244 cases of the outbreak were shown to have obtained either regular or occasional supplies from one or other of the three infected rounds. In 14 instances, however, no such connection with the infected milk was shown, but the circumstances are these :—

Case 1 (1222) was a nurse engaged in nursing Typhoid, who admitted not following out regularly her instructions for disinfecting her hands.

Case 2 (1113) was a medical student in charge of Typhoid cases.

Cases 3 and 4 (1098, 1279), the wife and child of a butler at a house where multiple attacks occurred : nothing definite could be ascertained as to their

access to the infected milk at this house (these were the only multiple cases in any house not on an infected supply).

Case 5 (1091) occurred in a young lady who was in the habit of drinking cold milk at various restaurants.

Cases 6, 7, and 8 (1036, 1084, 932) were all customers of the same retailer, whose store was in the street adjacent to one infected shop supply, but no admission as to any purchase could be obtained.

Cases 9 and 10 (1119, 104) were considered by the medical attendants, having regard to their subsequent development after notification, not to have been enteric fever. No Widal examination was made.

Cases 11 and 12 (1155, 1169) did not appear to be well-marked cases. No Widal examination was made.

Cases 13 and 14 (1013, 1120) were both definitely Typhoid, gave immediate Widal reaction, and were on apparently pure milk rounds. The milk round X passed one door, supplying the next house, but beyond this we have no clue to the causation.

Cases 1, 2, 9, and 10 may fairly be eliminated, thus allowing 234 cases to be accounted for out of 244, or 95·9 per cent.

The evidence as to milk being the true cause of the Enteric Fever cases appears to be overwhelming. The agreement on rounds X and Y between incidence of fever and milk supply might be held to be merely coincidence, but the sharp change from freedom to infection on round Z, following the almost experimental difference produced in the character of the milk by adding some of that from X, would appear, in conjunction with the previous evidence from rounds X and Y, and with that from the other two entirely unaffected rounds from the same farm Z, to logically exclude accidental causes.

As even this has been questioned, however, it may be well to examine the probability from another point of view. In three roads in Clifton (Clifton Park, Clifton Park Road, and College Road) there are 89 houses, of which 21 received their milk supply from an infected source (X, Y, or Z), the remaining 68 houses received milk from other sources. Seventeen of these 21 houses were invaded by fever within 23 days; no cases occurred in the remaining 68 houses. Supposing that we eliminate milk as a possible source of infection, so that the 21 houses differ in no known respect from the other 68 houses, and supposing one case of fever alone had occurred in these 89 houses. The probability that this one case would occur in one of this group of 21 houses would be $=\frac{21}{89}$; and the probability that a second case should occur (independently of the first case) in the same group, would be $=\frac{20}{88}$. But the probability that *both* cases would occur amongst this group would be

$= \frac{21 \times 20}{89 \times 88}$; and the probability that 17 cases occurring amongst these 89 houses would all be in the group of 21 houses, as they were, would be—

$$= \frac{21 \times 20 \times 19 \times 18 \times 17 \times 16 \times 15 \times 14 \times 13 \times 12 \times 11 \times 10 \times 9 \times 8 \times 7 \times 6 \times 5}{89 \times 88 \times 87 \times 86 \times 85 \times 84 \times 83 \times 82 \times 81 \times 80 \times 79 \times 78 \times 77 \times 76 \times 75 \times 74 \times 73}$$

$$= \frac{1}{126,638,200,257,597}$$

That is, there would be only one chance in 126 billions of this happening as it did, unless we allow the infected milk to be a true cause.

Incidence upon the College "Houses", and some Special Instances.

Of the eight College "Houses", containing many boys of susceptible ages, five were attacked, every one of which received, mixed or unmixed, the infected milk. Three "Houses" received the Z supply, but two were situated "above" the point at which the mixing occurred, and both these escaped entirely; the third was the first house served below this point, and four cases resulted. In one "House" receiving the unmixed infection X during September, and containing 55 persons, 33 were definitely attacked with Typhoid, and six others were attacked with temporary illness of an indefinite nature, probably Typhoid. In a second, a Master's house, with 10 inmates, receiving the same supply, six cases occurred; in a third, containing 43 inmates, which had apparently escaped up to the 24th October, it was found that it had not been put upon this supply until 17th October; and in due course two cases only followed on 24th and 27th October respectively. Of eight houses supplied after, but not before, this date, only this one was attacked, and only these two cases resulted; this result furnished an indication of diminution in the amount or intensity of the poison; in a fourth "House" on the Z supply, four cases only resulted; and in a fifth, two cases followed a single delivery of the X milk on one Sunday, when the boy delivering the milk relieved another boy who was taking a holiday. In no College "House" receiving other supplies did a single case occur.

In two instances a single exposure to infection has enabled the duration of the incubation period to be determined. In one of these, a girl of nine, on a visit to Clifton, drank some of the unboiled milk, and developed Enteric

Fever at the end of a week; in another, a child from another part of Bristol visited an aunt who was servant at a house supplied with infected milk, where five other cases occurred: she drank milk, and sickened in seven days. In one girls' school of 30 girls on the Y round, 20 persons drank milk at supper; of these five drank only boiled milk, and they have remained well. Of the 15 who drank unboiled milk, 12 have had Typhoid, and three only escaped; one of those who escaped had Typhoid fever severely in 1895. Unboiled milk was also used at lunch, but the main incidence seems to have been upon the drinkers at supper.

Clifton contains a very large number of schools, but no single school has been attacked, except those known to be supplied with infected milk.

In one large girls' day school, with over 230 pupils, 10 girls living in 5 houses were attacked by Typhoid, every one of them in houses supplied with milk known to be infected.

In the Grammar School, with over 200 boys, one only was attacked by Typhoid, and he lived within a few doors of the X store, and obtained his milk therefrom.

The last house supplied on the Z round after infection, was an Institution containing 63 persons, not one of whom was attacked; here a system of scalding the milk is in use.

The Source of Infection of the Milk.

The matter of primary importance in this outbreak was to determine the exact nature of the disease, and the manner of its distribution; after which followed the immediate prohibition of the X milk to which the evidence pointed as the infected vehicle.

The milk was bought up and destroyed under supervision from the first, until the conditions at the farm were made satisfactory; and this avoided any possible delay from following out seriatim the somewhat clumsy procedure of the Infectious Diseases Prevention Act. Instructions were also issued to the public to boil all milk before use.

Meanwhile, inquiries were prosecuted to discover, if possible, the manner in which the milk at X farm became infected. This question, of course, rests upon evidence entirely apart from that relating to the infection of the milk, and the connection of infection with this particular farm.

The Conditions at the Farm.—The cows upon the farm

were inspected by a veterinary inspector, and declared to be perfectly healthy. No illness amongst any persons at the farm could be traced. An analysis of the milk, taken on the 26th and 28th October, showed no evidence of added water.

A stream known as the "Ashton Brook" flows through the X farm, and close to the farm buildings. By the side of this stream, at a distance of only a few feet from it, was a pump drawing water from a shallow well, and used for all purposes of domestic or dairy use. The City Analyst's report on the water from this pump, and on the water from the adjacent stream, stated:—

"There is a remarkable closeness of agreement between these waters, which suggests that the pump is not supplied from a spring, but from the stream. Your inspection of the locality will have determined whether this is possible.

"The analytical results prove these samples to be highly charged with putrescent organic matter, whilst a direct microscopic examination, without the assistance of culture processes, shows them to be swarming with micro-organisms in great variety. Here also it is not possible to state with certainty whether part of the organic filth contained in these waters is or is not of sewage origin. From a careful consideration of the data, and from a knowledge of the water of the locality, I think there are distinct indications of sewage pollution; but the evidence, as is generally the case with stream waters, is not conclusive. However this may be, I have no hesitation in saying that these waters are not fit to be used for dairy work."

	X Farm Pump.	Stream at X Farm.
Saline ammonia .	.0030	.0032
Albuminoid ammonia	.0078	.0083
Nitrogen as nitrates and nitrites .	.06	.23
Nitrites . .	trace	strong trace
Chlorine as Chlorides	1.40	1.40
Oxygen absorbed in 15 min. at 80° Fahr.	.045	.088
Oxygen absorbed in 4 hrs. at 80° Fahr.	.072	.101
Total dissolved solids	37.0	37.0
Appearance . .	persistently turbid	turbid
Deposit . .	filmy deposit, consisting almost entirely of micro-organisms.	much organic *débris*, mycelium, infusoria, and bacteria.

Personal inspection of the course of the Ashton Brook showed that it formed practically the main sewer of the straggling village of Long Ashton, which extends for a distance of a mile or more along the main road. The road runs parallel to and at a higher level than the brook, at a mean distance of some 200 yards from it. The land rises abruptly from the brook towards the village, and the natural drainage of the village is towards the brook. The farm X is situated on this brook, and below the village. We

found at one spot that 37 houses had been connected to a 6″ sewer which discharged directly into the brook; at a second, that 22 houses had been connected to a cesspool, the overflow from which passed directly down a ditch into the same brook; at a third, that 40 to 50 houses, including one large laundry, had been connected to a cesspool, the overflow from which led through pipes to the brook; and one cottage at least on the brook discharges its sewage directly into it. These conditions are sufficient to account for the distinct indications of sewage pollution which chemical examination was able to afford.

On the side of the brook remote from the village, the land rises more or less abruptly towards the railway embankment of the Great Western main line, and again for some distance above this; so that the natural drainage of the whole valley is towards the Ashton Brook.

On December 4th Mr. Stoddart submitted this further report:—

"I have now completed the bacteriological examination of the samples of water received from you on October 26th.

"This branch of analysis may take, as you are aware, two directions, either an inquiry into the number and kind of the micro-organisms present, or the detection of a given species. In the present instance, the character of the samples was so clearly indicated by the results of the chemical examination already communicated to you, as to render any general inquiry into their bacterial contents quite superfluous: by direct microscopic observation they were seen to be thickly populated by schizomycetes. My attention, therefore, was strictly confined to the detection of the typhoid bacillus.

"The most approved method of carrying out this research is to distribute the water under examination through culture media treated in such a manner as to inhibit the growth of the majority of the commonly occurring forms, so that the typhoid bacillus if present may be the more readily revealed. Individual colonies arising from the multiplication of single organisms are then examined in pure culture, and subjected to certain distinctive tests.

"Without entering into technical details, I may say briefly that by this process, which is very tedious and laborious, I was not able to detect any bacillus capable of identification as that of typhoid fever; but that all the samples were found to contain large numbers of micro-organisms belonging to the group known as bacillus coli, thus confirming the opinion as to their polluted character based upon a consideration of the results of chemical analysis.

"Whilst I did not feel justified in neglecting to employ a method which is in general use, I also applied a process which I have lately devised, and which readily detects the typhoid bacillus under conditions which do not allow of its isolation by the usual method. By this procedure, instead of mechanically separating the individual bacteria in a water, and allowing them to develop apart from one another; the typhoid bacillus, if present, is encouraged to grow away from the complex mixture of non-specific forms with which it is associated.

"On applying this test to the suspended matter collected from a portion of each of the samples by centrifugal action, I obtained from the X farm water a growth exactly resembling that of the typhoid bacillus, whilst nothing similar was obtained from either of the other samples.

"It was noteworthy also that on again examining a sample of water from

the same well after an interval of five days, this suspicious organism was absent.

"Pure sub-cultures were prepared from the original growth, and the bacillus so obtained has been kept under observation now for some weeks, and has been subjected to every known test. After a very careful consideration of the results of these tests. I concluded that the bacillus under examination was not that of typhoid fever, as it presented well-marked and constant differences both cultural and morphological.

"It has frequently been suggested that the typhoid bacillus under some circumstances, such, for instance, as prolonged immersion in water, may lose some of its distiuctive features, resuming its normal character after re-introduction into the system. As it appeared to be of great importance in connection with this inquiry to clear up any doubt of this kind, it became necessary to test the behaviour of the bacillus upon a living animal. I therefore placed a pure culture in the hands of Dr. Allan Macfadyen, Director of the British Institute of Preventive Medicine, for this purpose.

"Dr. Macfadyen reports that this bacillus has no pathogenic action upon guinea-pigs; and that this result, in conjunction with those of culture tests referred to above, show that it has no relation with the bacillus of typhoid fever.

"I have, therefore, to report that I have been unable to obtain evidence of the presence of the typhoid bacillus in the samples of water submitted to me.

"As to the general bearing of this negative result upon the causation of the Clifton epidemic, I may point out that in similar inquiries the attempt to isolate the typhoid bacillus has been successful, if at all, only in one or two cases of recent infection of water; that in experiments by numerous investigators where the bacillus has been purposely added to polluted waters, all attempts to recover it have proved unsuccessful after an interval of about three weeks, generally much less; and that in the present instance probably a month elapsed after the conveyance of the infection by the milk before samples of the suspected water were obtained for analysis.

"In drawing any conclusions, therefore, from the non-detection of the typhoid bacillus in these waters, it will be necessary to bear in mind that, assuming the initial infection, the probability of obtaining positive results was extremely slight."

It will have been evident that while the X milk has been shown to have carried with it and distributed enteric fever along its own route, and to have conferred similar properties on the milks to which it was added, it has not been clear how the poisonous germs of typhoid became introduced into this X milk. This might have happened: (1) at Bower Ashton; (2) on the road to Bower Ashton; or (3) at the farm itself.

At Bower Ashton I can learn of no history of illness of a typhoid nature previous to the two cases which occurred concurrently with those in Clifton, and as a result of drinking the infected milk; nor do the conditions there appear to favour chance pollution of the water supply.

Secondly—Between this point and the farm an examination of the route shows no possibility of the addition of impure water, except from the Ashton brook, over which the cart carrying milk from the farm X passed daily.

Thirdly—The conditions at the farm were such that, given specific pollution of the brook, similar infection of

the pump-water was bound to occur, and the use of this for any dairy purposes was evidently fraught with the gravest danger.

The Search for Cases of Illness.—In addition to what I may call the intentional pollution of the brook by drains and overflows from cesspools, constructed to this end, it will be remembered that the slope of the ground on both sides trends towards the brook, so that surface drainage would naturally find its way into the brook, especially during times of heavy rains.

Now, the earliest cases of illness in Clifton seem to date their onset to the first week in October, while a very large second group of cases date their onset from the 10th or 12th October: this would indicate, allowing an average period of fourteen days for incubation of the disease, that the pollution was introduced into the water, and thence found its way into the milk somewhere between the middle and end of September. Dr. Fuller, of Long Ashton, who has most kindly furnished me with information, assures me that no typhoid has existed in Ashton to his knowledge for a considerable period.

There was no history of illness at X farm; nor could we learn, from an examination of the lists of customers, that the clothes of any infected patients had, previous to the outbreak, been washed at any of the local laundries. The chance of the infection of the stream by tramps suffering from mild or "ambulant" typhoid must always be kept in mind, but on inquiry we were informed that no cases of such illness had been detected passing through the Bourton Union.

We are unwilling at the present day to lightly accept the theory of the generation of a specific germ from excremental matters of a non-specific kind; and a failure to find any disease of a typhoid nature on the Ashton Brook watershed, while not affecting in any degree the evidence of the transmission of the typhoid poison through milk, would necessarily make the history of the outbreak an incomplete one.

In the course of our inquiries we learnt that a farm labourer, B. P., 47, had suffered, according to his wife's account, from an illness of two weeks' duration, commencing about the middle of September. His wife and daughter, a young child, were also ill, the symptoms in each case comprising sickness, pains in head and "stomach", and diarrhœa. Now, the cottage where these people live is situated at such a distance from the brook, and above the

railway embankment, and the disposal of the drainage of the cottage is so arranged, that it is difficult to see how persons confined to this house by illness could by any chance contaminate the brook. The man, however, works as labourer upon a farm, the fields of which extend below the railway embankment on the side towards the brook; and, as he himself insisted, he "did not stop at home half an hour out of work", but was at work all the time; and being ill while at work, he admits that his dejecta became deposited by the hedge-side. It became then of the first importance to determine, if possible, the nature of the man's illness.

On November 20th, Dr. Heaven secured a specimen of his blood, which was forwarded directly to Dr. Klein for examination by the Widal test. I met Dr. Klein in his laboratory in London on November 24th, and saw the reaction, which was well marked and characteristic of typhoid; indeed, Dr. Klein remarked to me, "it is one of the most distinctive I have ever seen". The necessary condition to induce pollution of the brook from these fields, which gradually slope towards it, is sufficient rainfall, especially in the form of heavy storms, during the period when the man thus suffering from "ambulant" typhoid was depositing infective material by the hedge-side.

Through the kindness of Mr. H. H. Harding, F.R. Met. Soc. of Fishponds, I have been able to ascertain the character of the daily rainfall during the month of September, and I find that between the 1st and the 8th September rain in excess of $\frac{1}{2}$ an inch fell on the 1st, 5th, and 8th; then followed a period of dry weather till the 17th, when heavy showers occurred during the afternoon. On the 19th, 22nd, 23rd and 24th, slight showers with drizzly rain occurred, chiefly in the evening; the 28th was also showery, and on the 29th over $\frac{1}{2}$ an inch of rain fell, the morning being showery, and heavy rain falling during the afternoon. There was thus ample opportunity for the washing down of infective material into the brook by the hedge-side or roadside ditches, and the infection so carried would reach the brook near Yanley Lane, which is at no great distance above the farm X.

Occupation in Relation to Attacks.

Murchison,* in his *Treatise on the Continued Fevers of Great Britain* (3rd Ed., p. 456), mentions that of 1,457 persons admitted into the London Fever Hospital suffering from enteric fever, nearly one-third of the patients were female servants, most of whom had been in comfortable situations. A similar heavy incidence upon domestic servants was noticed in the present outbreak, and more than one quarter of the total attacks fell upon this class.

The distribution of the infected milk was amongst persons practically all of the same class: private families, well-to-do lodging houses, and school boarding-houses; only one milk-round (X, low level) touched a working-class district through the medium of a small shop supplied with X milk, and from which, as a centre, nine of the casual cases and one death ensued.

The class of district in which the milk was generally distributed is well shown by the fact that in 120 houses, of which I have particulars, there were 1,012 inmates, of whom 302 were domestic servants.

Under these circumstances the only influence of occupation upon attack will be in regard to the greater or less incidence of the disease upon persons habitually consuming much or little milk, and I have accordingly grouped the cases under the following occupational headings:—

Occupations.	Attacks.			Fatality in each Class. Per cent.	Deaths.		
	M.	F.	Total Attacks.		Total Deaths.	M	F.
Householders and families	13	37	50	16.0	8	4	4
Masters and governesses ...	4	4	8	25.0	2	1	1
Boys and girls attending school (ages 3—20) ...	58	52	110	4.5	5	1	4
Domestic servants	3	62	65	21.5	14	2	12
Medical student. Nurses...	1	3	4	25.0	1	0	1
Others: Shop assistants ...	1	6	7	14.2	1	0	1
Totals	80	164	244	12.7	31	8	23

In this classification we at once notice the significantly

* The comparisons instituted with Dr. Murchison's figures are intended to bring out some salient features of milk epidemics as contrasted with the general incidence of the disease, and are not in any way a criticism upon his figures. The small extent of the Clifton outbreak would invalidate conclusions based upon its results.—D S.D.

heavier incidence upon women, not only upon the domestic servants, but also amongst members of families; so that in the aggregate we find 164, or two-thirds of the total number of attacks, in females. Murchison (*op. cit.*, p. 437) points out that, in general, enteric fever attacks one sex as readily as the other; and that of 5,988 cases admitted into the London Fever Hospital during twenty-three years (1848-70) 3,001 were males and 2,987 were females; or the males exceeded the females by 14.

The excess upon females in Clifton is by itself most suggestive of a milk-carried infection.

Attacks and Deaths by Age.

In the following Table the attacks and deaths are shown in relation to age groups.

Ages.	Attacks.			Fatality in each Class. Per cent.	Deaths.		
	M.	F.	Total Attacks.		Total Deaths.	M.	F.
0—5	3	7	10	10.0	1	1	0
5—10	10	18	28	7.0	2	2	0
10—15	14	22	36	5.5	2	0	2
15—20	38	28	66	6.0	4	2	2
20—25	2	27	29	31.0	9	0	9
25—30	2	22	24	16.0	4	0	4
30—35	5	14	19	10.5	2	0	2
35—40	2	7	9	11.1	1	1	0
40—45	0	9	9	22.2	2	0	2
45—50	2	3	5	20.0	1	1	0
50+	2	7	9	33.3	3	1	2
All ages ...	80	164	244	12.7	31	8	23

The incidence of the attacks by age is in this outbreak very much controlled by the special circumstances of the case, and especially by the fact of the milk having been distributed and used amongst large school boarding-houses. As the school age here extends up to twenty years, there is a notably large number of attacks at ages 15 to 20. But at all school ages from five upwards the attacks are significantly high.

Murchison especially points out the influence of age on the predisposition to enteric fever, and quotes the mean age of 1,772 admissions into the London Fever Hospital during ten years (1848-57) as 21.2. Of the cases admitted during a further period of 23 years (1848-70)

he found nearly one-half were between 15 and 25 years of age, and more than one-fourth were under 15, less than one-seventh were above 30, and only 1 in 71 exceeded 50. He concludes that persons under 30 are more than four times as liable to enteric fever as persons over 30.

In this outbreak the attacks upon children below the age of 15 were in excess, being nearer a third than a quarter of the total attacks, while the attacks at ages 15 to 25 are somewhat less than is shown in Murchison's figures: the excess in attacks upon younger children is significant in conjunction with the heavy incidence upon females and upon domestic servants, of the communication of the infection by milk. The attacks at ages above 30 are likewise in excess of Murchison's figures, for whereas he found less than one-seventh above this age, in the Clifton outbreak more than one-fifth of the total attacks occurred at ages above 30; and while he found only 1 in 71 of the attacks at ages above 50, in this outbreak 1 in 27 were above this age. The preponderance of attacks on females also continues to be noticeable at all ages above 30, as it was at every age-period below 30, with the single exception of the 15 to 20 period.

The general attack rate upon the 1,012 inmates of the enumerated houses amounted to 18.3 per cent., while that upon the 302 domestic servants amounted to 17.8, and that upon the 299 boys and girls of school ages amounted to 31.4 per cent. The small fatality amongst schoolboys and schoolgirls is in favourable contrast to the severe fatality amongst domestic servants.

The fatality or percentage case-mortality of this outbreak deserves some notice, and especially the small fatality at ages 5 to 20. Murchison (p. 606 *op. cit.*) points out that the death rate of enteric fever is not influenced by age to the same extent as that of typhus, and that there is a greater uniformity in the rate of mortality at different periods of life in enteric fever.

I have condensed my table to conform to the age-periods selected by Murchison, and here give the results side by side for comparison :—

Age-periods.	Case Mortality per cent. Murchison.	Clifton.
Under 10	11.36	7.89
10—15	12.86	5.5
15—20	15.48	6.0
20—30	20.46	24.5
30—40	25.90	10.7
40—50	25.0	21.4
50+	34.94	33.3

In this outbreak not only is the general fatality lower than Murchison found, but it is lower at every age-period with the exception of the 20 to 30 period.

This may be partly accounted for by the error to be expected in dealing with a small number of cases (244) in comparison with Murchison's figures, which are based upon 5,911 cases; it may also partly be due to the rule in milk-carried disease that the cases are generally of a mild type, a result probably indicative of the high normal resistance of many who yield only to the effect of repeated and large direct doses of the poison, and who under ordinary circumstances of infection would remain immune. The excess of mortality at ages 20 to 50 is notable in connection with the incidence upon domestic servants to which I have alluded above. Of the 13 deaths at these ages 9 were of domestic servants.

The influence of sex upon mortality from enteric fever was shown in the records of the London Fever Hospital by an excess of mortality amongst females amounting to 1 per cent.

In this outbreak 23 deaths occurred amongst females to 8 amongst males, or nearly three times as many.

Attack-rates in Supplied Houses at Various Age-periods.

A census of the houses supplied in Clifton by the two infected rounds, X and Y, and by the third round Z after infection, has enabled me to show the attack-rate upon persons living in these houses at various age-periods. (See Table next page,)

The houses on the regular milk rounds alone have been taken into consideration in this Table, to the exclusion of the casual supplies, as to which we can only know the population of those houses that happened to be attacked.

The attack-rate at all ages is seen to be heaviest upon the X supply, as was the house-incidence rate; but the mortality was proportionally heavier upon the Y supply. The heavy attack-rate at ages 15 to 20 on the X supply is noteworthy as connected with a large school-house, containing many boys at these ages, of whom 23 were attacked.

F.—Rates per 100 Living at Each Age-group.

Milk Round.	0—5	Rate per cent.	5—10	Rate per cent.	10—15	Rate per cent.	15—20	Rate per cent.	20—30	Rate per cent.	30—40	Rate per cent.	40+	Rate per cent.	Totals. All Ages.	Totals. Rate per cent.	Deaths. All Ages.	Deaths. Rate per cent.
X. Persons	7	42.8	21	47.6	29	41 3	76	47.3	175	13.1	55	32.7	90	13 3	453	25.1	13	2.8
Attacks	3		10		12		36		23		18		12		114			
Y. Persons	7	28 5	8	37.5	16	62.5	70	18.5	102	11.7	26	19.2	79	3.8	308	15.5	10	3.2
Attacks	2		3		10		13		12		5		3		48			
Z. Persons	0	—	4	50 0	8	62.5	56	14.1	32	15.6	18	—	36	5.5	154	14.2	2	1.2
Attacks	0		2		5		8		5		0		2		22			
Persons Totals	14	35.7	33	45.4	53	50.9	202	28.2	309	12.9	99	23.2	205	8.2	915	20 1	25	2.7
Attacks	5		15		27		57		40		23		17		184			
Total Deaths	0	—	1	3.3	2	3.7	4	1.9	10	3.2	3	3.0	5	2.4	25	2.7	—	—

Diagnostic Use of the Widal Reaction.

Between the dates 19th and 21st October, 1897, I found myself in this position: I knew definitely of five cases of undoubted typhoid, all apparently in the second week, if not later, of their illness; at the same time I had heard of a very wide prevalence of reputed "Influenza", the distribution of which, as it were, in "selected" houses, struck me as but little characteristic of this disease. For instance, one college house was seriously affected, whereas adjacent houses of the same class on each side were absolutely untouched.

I was also aware of the indeterminate nature of the onset of "typhoid" fever, in which, as Newsholme has shown, nearly 80 per cent. of the cases are not notified until the second week or later.

In addition, the habitual exemption of Clifton from prevalence of this disease was, I felt sure, liable to mislead the clinical observer in dealing with the early stages of a widespread prevalence of a disease accompanied by obscure feverish symptoms,

At the same time it became most essential in the public interest to clear up, in as short a time as possible, any doubts as to the actuality of a typhoid outbreak, so that the cause might be ascertained and removed. Now the Widal reaction will give results as early as the fourth or fifth day in cases of typhoid, and I at once determined upon the wide application of this test.

The use of the Widal reaction in this outbreak is, I think, deserving of some attention; for, so far as I am aware, this is the first occasion upon which it has been used on a large scale and has proved successful, not only for confirming selected doubtful cases, but in "establishing" a diagnosis amongst diverse cases with feverish symptoms, where clinical observation was as yet at fault.

Most important issues hung upon the success or failure of my attempt: on the one hand the closure of the College, already mooted; and, following this, the establishment of panic and irreparable damage, not only to this public school, but to Clifton and to the city.

My reliance upon the test seems to be fully justified by the results, a summary of which I submit:

In the case of 192 examinations made during the course of the outbreak, between October 19th and December 20th, I have been able to collate the Widal and clinical results; and I find (using a dilution of in most cases 1-10, or

1-15, but in no case exceeding 1-20), that 121 gave a *complete* reaction, *i.e.*, involving characteristic clumping, and loss or marked impairment of motility within half an hour, while 17 more gave the *complete* reaction within the hour.

All these positive results were clinically confirmed with two exceptions, in which the clinical development of the cases did not support the diagnosis of typhoid; so that, allowing these not to have been typhoid, the error did not amount to 2 per cent.

In the case of fifteen specimens examined, some definite clumping was observed only after a period extending much over an hour, and considerable motility persisted. Of these doubtful cases six developed as clinical typhoid, and nine proved not to be cases of this disease.

In the case of 39 other specimens examined, negative results were obtained, of which 4 developed clinical typhoid; in two of these latter an opportunity of a second examination was afforded, and gave then a positive result: in the other two, a second examination was not made. The other cases all proved to be not typhoid fever, thus agreeing with the Widal reaction. I think I am justified in considering these results satisfactory, especially as the examinations were made under great pressure.

In a large number of cases the reaction I obtained was practically "immediate", complete clumping and entire loss of motility taking place almost at once.

I use a hanging drop upon a cut-out moist blotting-paper cell, and in the edge-region of the drop characteristic phenomena seem to occur.

In these "immediate" reactions, the edge-track, which is the scene of the busiest activity before the addition of the serum, becomes quite deserted, and for some time the bacilli seem to have disappeared from the entire field, until found in definite "spellican" masses in various parts of the field.

Many other cases showed a reaction not quite so immediate, but "complete" within 5 or 10 minutes; in these I noticed often a peculiar "spinning" motion of individual bacilli, to be seen frequently in the tangle of a forming clump: the bacilli seeming as if entangled by one or more flagella, and spinning rapidly round in the effort to get free; this seems a somewhat definite indication of typhoid clumping in progress.

The varieties of false clumping which occur do not seem

likely to cause confusion with a little practice; but in certain cases of scarlet fever upon which I tried the reaction, I observed in one no reaction in half an hour, marked clumping in 1 hour 10 minutes, but the clumps loosely aggregated, flat, and floating freely in the fluid, the free bacilli still active; after 2½ hours the masses "unclumped", and in 3 hours the bacilli were quite dissociated, and as active as in the original broth culture.

The observations during the epidemic were made, as I have stated, with low dilutions, mostly 1-10 and never exceeding 1-20; but I now examine a low dilution, 1-10 or 1-15, and a high dilution, 1-40 or 1-50; but if the low dilution gives a negative result, the higher dilution is of course unnecessary. I find generally that, in the blood from a case of actual typhoid, the reaction in the case of the high dilution is very little less rapid and marked than in the low dilution.

The results obtained show, I imagine, that considerable reliance can be placed upon the reaction when "complete", *i.e.*, as to aggregation and loss of motility, within a short time limit, even when 1-10 or 1-15 dilution alone is used. I do not think this time limit should exceed an hour even for 1-50 dilution.

I used two cultures, one an agar sub-culture from one supplied to me by Dr. Klein; the other an agar sub-culture from the spleen of a fatal case during the outbreak; broth cultures are made from one or another of these daily: they are both extremely active, especially the older one; for measurement, drop measurement on a watch-glass seems sufficiently accurate, and is handier, especially with small quantities of blood. I prefer blood collected in small centre bulb glasses: vaccine tubes are vexatious to blow out, and apt to get overheated in the sealing—which accounts, I imagine, for some of my negative results that proved wrong, as they occurred under these conditions of collection.

Zeiss D or an English ⅛-in. objective appear the most convenient for observation.

Comparison of Results.

Of the Widal examinations, 36 were of cases admitted to the Royal Infirmary, Bristol, and I have been able through the courtesy of Dr. Stack, the House Physician, to compare the clinical course of the cases with the Widal result.

Of the 36 cases, 26 gave a positive result: of these 14 acted almost immediately, clumping and loss of motility being established in a few minutes; 9 acted not quite so rapidly, the reaction being complete within 15 minutes; the remaining three showed a complete reaction within 30 minutes.

The dilution varied from 1 in 10 to 1 in 20, but did not exceed this.

The clinical course of every one of these 26 cases determined them to be typhoid; in one case (927) F. 55, the symptoms were indefinite, the case being complicated with considerable bronchial mischief, but a post-mortem confirmed the Widal reaction, which was complete within five minutes; in two other (895, 929) cases, extensive and destructive ulceration of the large intestine was noticed, and in one of these the small intestine seemed to have escaped altogether, and Peyer's patches were normal in appearance. Another fatal case (1,235) in a boy of 11, which gave on the 16th day of illness a very definite Widal reaction complete in 10 minutes, did not present during life any definite symptoms of Enteric Fever, but the boy was believed to be suffering from acute lobar pneumonia. The diagnosis of Enteric Fever was only provisionally made on the Widal result, but the post-mortem examination showed characteristic ulceration, though partial, of Peyer's patches, and the pneumonia was seen to be septic. Suppurative otitis media was also found to exist, and the B. Coli was recovered both from the ear and the lung.

Three cases gave indefinite results, much exceeding the time limits:—

1. Clumping did not begin for 30 minutes, and proceeded slowly, was well marked in 1 hour 10 minutes, some motile forms persisting (1 in 10).

2. No reaction in 1 hour 45 minutes, some clumping in 2½ hours (1 in 10).

3. Some clumping in 2 hours, but still considerable motility after 2¾ hours (1 in 10).

4. Clumping marked in 1 hour 20 minutes (1 in 15).

None of these cases were enteric; the first was a case of gastric ulcer, the last of general tuberculosis.

Five cases gave quite negative results (1 in 10 to 1 in 20) over periods from 1¼ to 6 hours, and clinically were determined not to be Enteric Fever; one was a case of phthisis.

Of 12 examinations made for Dr. T. M. Carter, on the low level round, six gave positive results commencing

within 5 to 20 minutes, and marked within the hour, while six gave definitely negative results.

All coincided with the clinical development of the cases, except one of the positive results (991), a girl of 6, who had no history of previous typhoid, but gave a history of malaise and loss of appetite 10 days, diarrhœa 2 days, milk from a non-infected source; she lived next door to a case of Enteric Fever. The blood from this case gave complete positive results on 28th October within 15 minutes, on 4th November within 30 minutes, and on 24th November within 20 minutes, but the symptoms subsided with no rise of temperature or other indication to retard convalescence. The father of this child suffered at the same time from an attack of intestinal catarrh, with slight rise of temperature, subsiding on the second day. His blood gave a negative result over 3 hours on 20th November.

The Nature of the Outbreak.

The fact that for fourteen days, or longer, the nature of the disease remained still clinically obscure in many instances would, at first sight, appear to point to some unusual type of enteric fever; but I am unable from the notes kindly sent to me of over eighty cases to say that this was in any general sense the case. The early stages of typhoid are admittedly difficult to recognise, and it is not until the second week or later, as we have seen above, that the decision is usually made; it was the clinical recognition of certain cases after such an interval that in this outbreak gave the first clue in regard to the rest of the cases. As I have suggested above, also, the very exceptional circumstances of such a sudden outburst in a town notably free from enteric fever tended to throw the clinical observer wrong: the error was indeed a testimony to our habitual freedom from fever.

But such variations as were observed were those to be looked for in milk-borne infections, where large numbers of persons of varying susceptibilities are infected and re-infected with successive doses of poison administered directly to the alimentary tract; and the manifestations varied from the severest type of disease, with every clinical feature, to the mildest, in which nothing but the occurrence of other and undoubted cases of typhoid in the same house and the positive result of the Widal reaction would have suggested the diagnosis of typhoid. Thus in one house the records of eight cases show one death, four cases were

severe, one mild but prolonged, and two absolutely trivial, some slight rise of temperature for two days being all the clinical symptoms observed.

There were, it is true, frequent deviations of the disease from the classical type, in some cases indicated by an unusual course of the temperature, by the absence of abdominal symptoms, by the preponderance of meningeal or of pneumonic symptoms, by the intercurrence of unusual erythematous rashes, with every appearance of scarlet fever, and in some cases by the transient nature and extreme mildness of the illness; but such variations are, I imagine, more common than is generally recognised; and with regard to the milder cases it is probable that very many cases of typhoid fever of this sort habitually escape observation altogether in the ordinary course, though they would give ready and unmistakeable reactions to the serum test.

The evidence at our command seems to point to an infection operative for a short period only, so that by the time our attention was drawn to the mischief which had attacked the city from without, any action of the Health Department was powerless to limit the primary cases of the outbreak. There can be little doubt, however, that the prompt determination of the nature and method of spread of the disease did much to limit secondary cases by hastening the adoption of proper precautionary measures; and it served also the most useful purpose of restoring public confidence and averting panic, which might otherwise have done irreparable injury, not only to Clifton as a health resort, but also to the city as a large manufacturing and educational centre.

Since the outbreak medical practioners are very generally submitting specimens of blood from doubtful cases of continued fever for examination, and the Widal test promises to establish itself as a reliable and delicate help to clinical observation; had this examination been general at the beginning of the outbreak, much sickness might, no doubt, have been prevented.

Our experience in Bristol has brought prominently forward the question of the control of milk supplies. A large city is necessarily dependent for its milk supply very largely upon surrounding rural areas, and laxity in these districts reacts not only upon themselves, but chiefly, and sometimes very sorely, upon the crowded areas they supply.

It is not likely that larger powers will be given to urban authorities to go beyond their limits to inspect farms and

dairies yielding them supplies; and such inspection would be difficult to exercise and maintain where, as in this city, three counties supply us with milk from an aggregate of 154 farms. Nor will the partial adoption of a control system on the basis of the Copenhagen plan ensure general safety. It seems that the matter can best and most effectually be dealt with if County Councils bestir themselves to see that the rural authorities carry out consistently and fully the powers of control already possessed.

ENTERIC FEVER AT NORWICH: A TRIENNIUM OF TYPHOID.

STATISTICS RELATING TO THE HOME SURROUNDINGS OF 656 CASES NOTIFIED DURING THE YEARS 1895-6-7.

BY H. COOPER-PATTIN, M.A., D.H.P.

(*Read*: *May 20th*, 1898.)

SINCE the year 1880 enteric fever has been a notified disease in the city of Norwich; it has prevailed there within all living memory; and seeing that the city itself has been a relatively populous place for at least ten centuries, it is fair to suppose that local lineage of typhoid is very ancient: for it by no means follows that because we doctors did not differentiate enteric among "Low Fevers" until a comparatively recent date, that the disease did not run back to immemorial times! We gave it a special name, and later a "specific" history; in the rightful use of words we cannot be said to have discovered but to have *labelled* it.

Before directing your detailed attention to the appended "statistics relating to the home surroundings of 656 cases notified during the years 1895-6-7," I will give, in brief abstract, some account of the characteristics of the soil, water, and drainage of Norwich.

(1) Soil:—

The geological construction of the soil underpropping the city is simple in character. The higher levels are made up of glacial beds, through which the valleys have been excavated; the said valleys exposing* at their margins

* In what is known as "The Lollard's Pit" the following beds have been exposed:—

Glacial Drift	Sand and gravel, 15 ft. Brick earth (stony loam), 10 ft.
Upper Crag	Pale grey and yellow sand and fine shingle, 15 ft. Streaks of laminated clay. False-bedded brown and yellow sand and shingle, 16 ft. Chalk and flints, 30 ft.

the crag formation and chalk, while gravel and alluvial deposits occupy the lower ground. The chalk, which at Norwich is more than 1,000 ft. in thickness, underlies practically the whole of the city, and comes to the surface in the Market Place, and in other parts at a similar level; it may be reached at no great depth in all parts of the municipal area. The order of the succession of the glacial and crag beds is shown in excavations on the sides of the high ground on the other side of the river, surmounted by what is known as Mousehold Heath, between which Heath and the city proper winds the valley of the Wensum. [The river enters the city on the north-west, makes four bends in its course, and leaves it at the south-east.] Except for some layers of peat in this valley, and a bed of brick earth over part of the higher ground (near the Victoria Station), the soil of the city is porous in character, and much percolation of fluid takes place through the gravels, &c., into the chalk. The general trend of the drainage of the greater part of the inhabited area of the city is towards the Wensum.

(2) Water:—

The water supplies of Norwich are drawn from the River Wensum and some wells. The Wensum rises at a—for Norfolk—relatively high plateau near to Lakenham, and meanders, gradually increasing in volume, some thirty miles before it reaches Norwich. In various parts the river skirts arable land, but for by far the greater portion of its course it flows by grassy pastures. Sundry hamlets border, but only very few houses actually abut upon, the stream or its immediate tributaries. Here and there mills are stationed upon the banks, the most important being *The Times* paper mill at Taverham, four miles above the intake. The normal rate of flow is about two miles an hour, and the water, in its riverine condition, contains, as might be expected, some vegetable albumen, and is moderately "hard".

At Heigham, well above the city, a company takes water from the Wensum, and after filtering and storing the same supplies the inhabitants of Norwich with it. The intake of the company averages 1½ million gallons per diem. A series of screens at the intake prevents the passage of leaves and other gross impurities. The water is first of all pumped into a depositing reservoir, and is passed from that to the filtering beds, of which latter there are at

present three in working condition, each 25,000 sq. ft. in area.

These filters are cleansed and used in turn, two being constantly at work. (The company is increasing their number, and constructing a new sedimentation tank, to meet the prospective needs of our people.) The water passes over fountains, and is taken into spray before being filtered. Each filter works from ten to fourteen days in summer, and from fourteen to twenty-one days in winter. When a testing filter is going to be brought into use, it is slowly filled with water, and left at rest, except in winter, for twenty-four hours before filtration is actually started. I mention these details to give you assurance that all possible care is taken at our waterworks. I can confidently affirm that there are none more capably managed in the kingdom; the service pipes, &c., are of the best quality, and the mains are duplicated.

The filtering beds are made up of coarse stone and grit, graduated in fineness, to a height of 2½ ft. from the bottom; on the top of this clean sea-beach sand is deposited to a height varying from 2½ to 3½ ft.; it is rarely so low as, and never below, 2½ ft. This sand is cleansed in the ordinary manner by scraping off the superficial layers, fresh sand being deposited as occasion arises. The rate of filtration is usually 1·3 gallons per hour per square foot, a rate which is occasionally increased to 1·5 gallons. (I believe the average rate of filtration among the London companies is about 2 gallons per square foot per hour.)

After filtration the water is pumped from Heigham into two admirably-constructed reservoirs (covered), situated at Mousehold and Lakenham, each about 150 ft. above the level of the intake. From these reservoirs the water flows by gravitation into and about the city. The service is constant, and the average supply *per head of the population using the water* is about eighteen gallons per diem. Norwich, it may be parenthetically remarked, is a city with many fixed baths; there are less than 700 in the whole city; this does not imply a want of cleanliness, but a preference for the cold "tub" rather than "slipper" bathing: using so three in place of, perhaps, thirty gallons of water. Then you must bear in mind the fact that little more than a fourth of the houses are supplied with w.c.'s, and use water for the disposal of excrement, so that the actual supply per person is sufficiently plentiful—more so, in fact, than the bare figure suggests.

The people who do not drink the company's water

depend for their supply upon wells. The quality of the water in these, and their depths, varies; some very deep wells, going down into the chalk, yield water of exceptional purity; but the majority of the wells in use are under 50 ft. in depth, and the water, while commonly "passable"—that is to say, not sufficiently polluted to be condemned on chemical analysis anyway—is of varying and, on the whole unsatisfactory, character. I have had samples from one and the same well analysed at different periods, with almost invariably differing results, and yet have had to wait for quite a long period before a sample proved bad enough to condemn on analysis. The law, in its present state, is not sufficiently helpful. It often happens that the use of waters which a medical officer of health regards with suspicion, and believes must, sooner or later, become dangerously polluted, cannot be condemned, because the result of the chemical analysis does not entitle one to take that step—which may be State but is certainly not preventive hygiene. About 12,000 people, as nearly as I can estimate the number, in Norwich still draw their water from wells.

Sewerage: a new system costing about £170,000 being brought to completion. Shone's ejectors will raise the sewage from low-lying to higher levels. After collection at Trowse Pumping Station, the crude sewage is pumped on to a farm 500 acres in extent, about three-quarters of that area being intermittently irrigated with the fluid. The sewage receives no chemical or bacteriological treatment before being applied to the land. Street gratings have in the past been much complained of, as have also the side gullies, which were mostly "untrapped". These side gullies are now generally "trapped", and many ventilating shafts have been erected: changes which have been urged by me, and have and will meet with my hearty approval. I am satisfied that sewer air is a predisposing agent in the propagation of typhoid.

I append the occupations of the householders whose dwellings were affected in 1897, to give you a general idea of the class of people among whom we find typhoid in Norwich. It will be observed that in the majority of the cases the householders are not of "the well-to-do".

The secondary cases occurred in this order:—

In houses containing only	1	bedroom	...	...	8·0	per cent. of the cases.
„	„	2	bedrooms	...	...	40·0	„	„
„	„	3	„	...	...	40·0	„	„
„	„	more than 3	bedrooms		...	12·0	„	„

Taking all which facts into consideration, the following summary represents the conclusions I am arriving at:—

(1) That enteric fever (as shown by the notifications) has been prevalent in Norwich for the last 17 years.

(2) That while there has been, on the whole, a seasonal increase of the disease in the autumn months, the disease has persisted throughout the year.

(3) That what may be described as the endemicity of the disease in the city appears to be associated with the methods of disposing of excrement followed, and with defects in the sewerage and drainage.

(4) That specifically polluted water and milk may be occasional causes; there is no sufficient evidence that they constitute the main persisting causes.

(5) That bedroom crowding exerts a predisposing influence, probably by lowering the standard of healthiness in those subjected to such undesirable household conditions.

(6) That emanations from sewer gratings, untrapped gullies, and, more particularly, collections of festering excrement, exert *a predisposing influence upon those exposed to them.*

(7) That the existence of some thousands of fixed and movable "bins" in near proximity to dwellings is unquestionably a source of continuous pollution alike to the *soil* and to *air* in the neighbourhood of the dwelling, and affords *favourable conditions for fostering a filth disease like Enteric Fever;* and that in scavenging, portions of excrement are liable to fall on to, and get trodden into, imperfectly-paved yards, alley-ways, and streets.

(8) That the high proportion of chlorides and nitrates to be found in the soil of the city bears testimony to *organic pollution in the past, and furnishes favouring material for promoting the existence of the specific micro-organism of Enteric Fever.*

It will be noticed that whereas the death-rate in 1880 from this disease averaged 20.5 per cent. of the cases notified, or, roughly, one case in every five, the death-rate last year was one case in every seven. It does not necessarily follow that these figures represent the true state of the facts. That there has been on the whole a diminution in the case mortality cannot be doubted; but it must be remembered that most probably a number of the milder cases of the disease were not recognised and notified in

1880. Increasing skill in diagnosing the disease in its lighter form has, in my judgment, led to a more accurate correspondence between the number of notifications sent in and the actual amount of the disease, although I still think that a number of cases of enteric fever, of what is known as the "ambulatory" type, escape notification and never receive medical treatment; so that in Norwich, as elsewhere, the notifications furnish a reliable guide to the relative prevalence of the disease, but must not be regarded as accurately representing the full amount.

Prevalence and Mortality in Past Years.

Notifications of Enteric Fever.	Year.	No. of Deaths.	Mortality Rate.
180	1880	37	20.5 per cent.
50	1881	15	30.0 ,,
47	1882	8	17.4 ,,
34	1883	11	32.3 ,,
121	1884	30	24.8 ,,
584	1885	92	15.6 ,,
262	1886	39	14.5 ,,
136	1887	20	14.7 ,,
171	1888	19	11.1 ,,
166	1889	22	13.2 ,,
176	1890	31	17.6 ,,
163	1891	21	12.8 ,,
106	1892	19	17.9 ,,
314	1893	36	11.4 ,,
150	1894	22	14.6 ,,
226	1895	24	10.6 ,,
196	1896	20	10.2 ,,
234	1897	33	14.0 ,,

Turning now to the 234 cases notified in 1897, and comparing them with 1896 and 1895, we find :—

(*a*) Sex :—

That 49.5 per cent. of the cases occurred in males, and 50.5 per cent. in females, whereas in 1896, 51.5 per cent. occurred in males, and 48.5 per cent. in females; and in 1895 only 44.2 per cent. were males and 55.8 females. Why these changes have occurred I do not know; the females are commonly more home-keeping in their habits than the males; on the other hand, the latter expose themselves to more extended means of infection.

Average, Three Years: Males, 48.4 per cent.; Females, 51.6 per cent.

(*b*) Age:—

				1896.	1895.	Three Years' Average.
12.5 per cent.	of the patients were	under 5 years	of age	9.2	7.5	9.75
18.75 „	„	between 5 and 10	„	15.3	22.5	18.85
17.0 „	„	„ 10 and 15	„	25.0	18.5	23.5
16.75 „	„	„ 15 and 20	„	17.3	17.75	17.25
12.0 „	„	„ 20 and 25	„	9.2	10.0	10.4
12.25 „	„	„ 25 and 35	„	15.3	12.75	13.4
7.25 „	„	„ 35 and 45	„	6.2	5.75	6.4
4.5 „	„	over 45	„	2.5	5.25	4.0

The rise which occurred between the ages of twenty-five and thirty-five in 1896 was not maintained. It will be noticed that no less than 48.0 per cent. of the cases occurred in children under fifteen years of age—what may be called juvenile typhoid being a marked characteristic of the enteric fever which prevails in Norwich. In 1896, 48.5 per cent. more cases in persons over forty-five years of age were notified: in fact, nearly double the number which reached us in 1896. There were more cases under five than in either of the preceding years.

Average Number of Cases under Fifteen: Three Years, 48.6.

(*c*) Crowding:—

Average Number of Occupants.

7.5 per cent.	of the affected	dwellings	had only 1 bedroom	...	3½ persons.
37.0 „	„	„	2 bedrooms	...	2½ „
42.5 „	„	„	3 „	...	2 „
13.0 „	„	„	4 or more	...	1 person.

Average of Three Years—Average Number of Occupants.

5.6 per cent.	of the affected	dwellings	had only 1 bedroom	...	3.16 persons.
35.9 „	„	„	2 bedrooms	...	2.5 „
46.5 „	„	„	3 „	...	2.25 „
11.8 „	„	„	4 or more	...	1 person.

In 1896 the corresponding percentages were 1 bedroom, 4.4 per cent.; 2 bedrooms, 36.7 per cent.; 3 bedrooms, 49.4 per cent.; 4 or more bedrooms, 9.5 per cent. The relative crowding was 3, 2½, 2¼, and 1 person per room. In 1895 these percentages were 1 bedroom, 5.0 per cent.; 2 bedrooms, 34.0 per cent.; 3 bedrooms, 48.0 per cent.; 4 or more bedrooms, 13 per cent. The relative crowding in 1895 was 3, 2¾, 2¾, and 1, so that the disease in 1897

invaded more of the worst and of the best houses than in 1896, and more of the worst and fewer of the best than in 1895. In estimating the influence of "man-crowding", I have only concerned myself about the number of sleeping rooms, the rooms in which crowding becomes important. The census returns are only helpful here in respect of tenements consisting of one room, which room must, of necessity, be used for bed and living room. At the 1891 census there were 2.1 per cent. of the dwellings which consisted of one room only; and when it is remembered that a large proportion of these are occupied by one old man or woman living alone, the incidence of the disease in one bed-roomed houses is probably much heavier than the figures represent.

(*d*) Water-Supply:—

87.5 per cent. of the affected dwellings were supplied with the Company's water,
12.5 „ „ „ from wells.
In 1896 the corresponding proportions were 85.5 and 14.4 per cent.
In 1894 „ „ 81.0 and 18.0 „

Average of Three Years.

84.6 per cent. of the affected dwellings were supplied with the Company's water
15.4 „ „ „ from wells.

The proportions in which houses are supplied with "pipe" or with well water are quietly but continuously altering; each year sees an increase in the number of houses supplied by the Company, and a decrease in the number of those drawing water from wells. I believe that at the present time about 89 per cent. of the houses are supplied by the Company with water; bearing that fact in mind, it will be at once seen that if we are to attribute the propogation of typhoid to water supplies, we have to impeach the Company as well as the wells. By my advice thirty seven wells were closed during the year, the water drawn from them being shown by chemical analysis alone to be unfit for drinking purposes. We have, thanks to a resolution passed by the sanitary committee, been enabled to submit the Company's water to the much more rigid test of bacteriological investigation, in addition to chemical analysis, with satisfactory results. I do not myself believe that any serious portion of our typhoid was occasioned in 1897 by the consumption of contaminated water; else we ought to have had a heavier incidence of the disease among the drinkers of well waters, and also among the well-to-do

drinkers of the Company's waters. That the Company expends great care upon the filtration and storage of the water it supplies to the citizens, I feel it my plain duty to bear witness; and short of the demonstration by bacteriological experts of the specific bacillus of enteric fever being distributed with the fluid, I see no sufficient reason for dissenting from the opinion expressed by the Official Analysts that it is "a perfectly safe water for dietetic use".

(*e*) Milk Supply:—

In 1897.	In 1896.	In 1895.
2.0 per cent. of the patients drank no milk	8.0	10.0
29.0 „ „ „ it in the raw uncooked condition	24.0	25.3
68.0 per cent, of the patients drank it only when first boiled or cooked in puddings or in hot tea, etc. ...	67.5	65.0
1.0 per cent. of the patients used condensed milk ...	1.0	0.0

Three Year Average.

6.6 per cent. of the patients drank no milk, 26.0 per cent. drank it in the raw uncooked condition, 66.8 per cent. drank it only when first boiled or cooked in puddings or in hot tea, etc., and 0.6 per cent. used condensed milk.

As in 1896, I think that milk propogated little enteric fever among us; its influence anyway must have been limited, for practically it could be only a source of infection in 30 per cent. of the cases among the drinkers of the uncooked article. At the same time I am bound to say that, but for the fairly general cooking of the milk consumed among us, we are practically at the mercy of the surrounding districts, so large a portion of our supply comes from outside the city; and unfortunately the want of a County Medical Officer of Health is felt in more than the arrangement of concerted action in the matter of milk-supply between the City and County Sanitary Authorities.

(*f*) Shell-Fish:—

So far as I could learn, 76.0 per cent. of the cases ate no shell-fish, either in the cooked or uncooked conditions, within three weeks of the outset of their ailment. In 1896 the corresponding percentage was 88.0, so that this possible source of infection could not affect more than one-fourth of the cases last year, even supposing that the whole of these ate their shell-fish in an uncooked condition.

Three Year Average: 82.6 *per cent.*

(*g*) Disposal of Excrement :—

59.0 per cent. of the affected dwellings used "bins".
33.0 „ „ „ pail closets.
8.0 „ „ „ water-closets.

(Of the water-closets the Inspectors reported 2.0 per cent. as defective.)

In 1896 the proportion were 58.0 per cent., 32.0 per cent., and 12.0 per cent., and in 1895 64.0 per cent., 24.0 per cent., and 12.0 per cent., respectively. The relative increase in 1897 took place in the dwellings supplied with "bins" and pail closets.

Three Year Average: "Bins", 60.3 *per cent.; Pail Closets,* 29.3 *per cent.; and Water-Closets,* 10.4 *per cent.*

The number of houses supplied with water-closets amounts to a little more than one-fourth of the whole; rather more than another fourth have pail closets, and the remainder "bins". Regarding the pail closets as small moveable "bins" (which indeed they are), it will be seen that 92.0 per cent. of the cases occurred in dwellings which retained the excrement of the occupants about them.

Three Year Average: 89.6 *per cent.*

(*h*) Household Drainage :—

At 44.0 per cent. only of the affected houses the inspectors reported the drainage as "good". In 1896 the corresponding percentage was 41.0 per cent., and in 1895, 39.0 per cent.

Three Year Average: 41.3 *per cent.*

That means in the others that some defect in the drainage, such as no sink (which means that all slop and other waste water would be pitched about the yard), sink waste-pipe not disconnected, or loose and defective traps", etc.

Character of Yard :—

		1896.	1895.
0.5 per cent of the affected dwellings had no yard	...	1.3	2.0
30.0 per cent. of the dwellings had paved yards ...	...	19.0	33.0
31.5 „ „ unpaved yards	...	31.0	35.0
7.75 „ „ partly paved yards	...	7.75	9.0
30.5 „ „ cobbled yards	...	30.5	21.0

Three Year Average.

No yard, 1.25 per cent.; paved yards, 27.25 per cent.; unpaved yards, 32.5 per cent.; partly paved yards, 8.16 per cent.; and cobbled yards, 27.3 per cent. In other words, 70 per cent. of the dwellings had yards more or less liable to have the subsoil soddened with moisture and impurities. I have repeatedly drawn attention to the importance of having the soil which adjoins a dwelling covered with some material impervious to fluids, else it cannot be kept dry. A large number of the poorer dwellings in this city have no properly constructed "damp course" in the walls, and, in addition, have not had a thick layer of concrete laid under the bottom floors; in such cases moistening of the subsoil must lead to dampness in the dwelling, to say nothing of the deleterious ground-air which will be forced upwards by the rising of the ground-water from time to time, and always more or less sucked into the dwelling owing to its atmosphere being warmer.

(*j*) Food Store:—

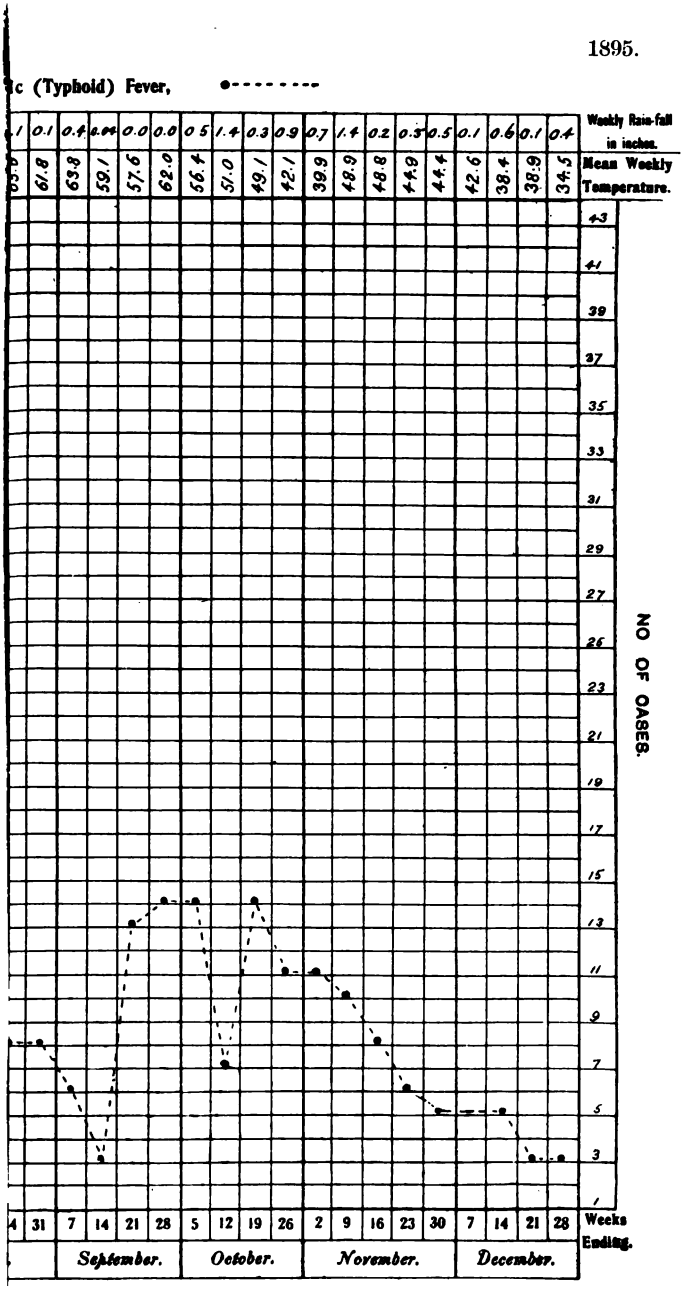
In 4.5 per cent. of the affected dwellings food was stored in a receptacle situated inside the living room, but having direct communication with the external air; in 5.4 per cent. food was stored in a similarly ventilated receptacle elsewhere; 7.2 per cent. of the dwellings had the household food stored in an unventilated receptacle (namely, having communication with the external air) in some part of the house other than the living room; and in no less than 82.9 per cent. of the dwellings the food was stored in some unventilated receptacle in the actual living room. In 1896 the food was similarly stored in 85.4 per cent., and 1895 in 86.0 per cent., of the affected dwellings.

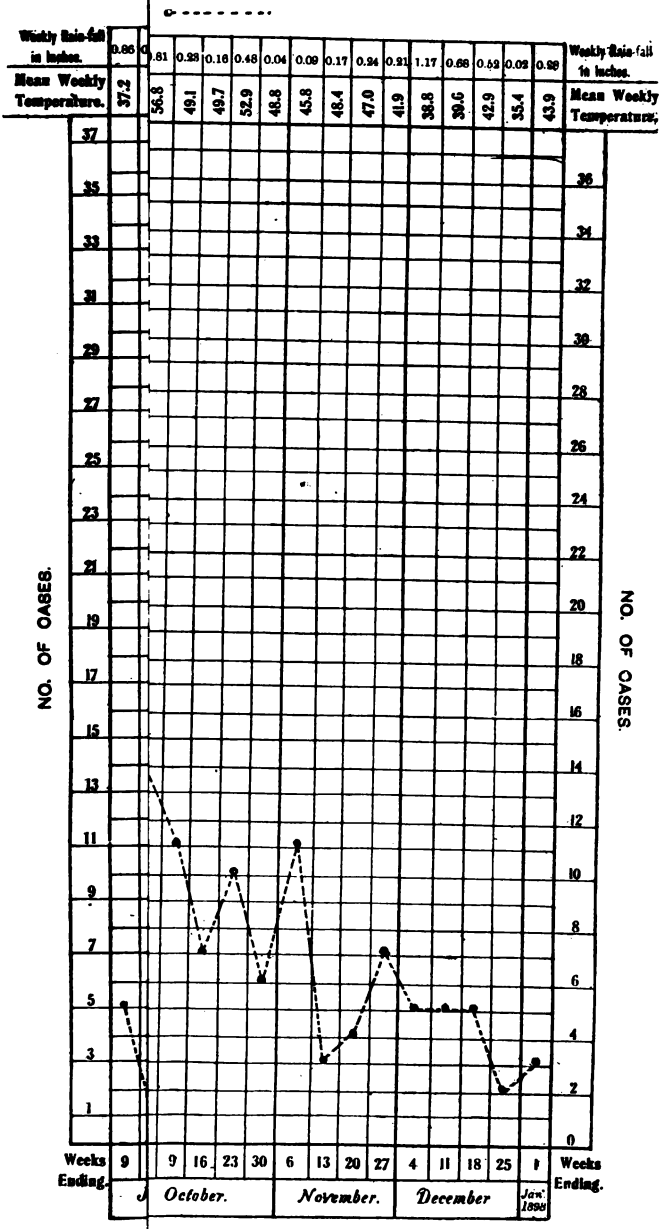
It is worthy of notice that in 82.9 per cent. of the affected dwellings the food was stored in the living room, and therefore in an atmosphere more or less stale and impure. Withont assuming a direct connection between such food and a disease like typhoid, it will be obvious that articles of food such as milk, butter, bread, etc., kept in such surroundings might easily become contaminated with impurities.

Three Year Average: 84.75 *per cent.*

(*k*) Nearness to Sewer Gratings and Gullies:—

				1896.	1895.
17.0 per cent. of the affected dwellings were within			20 ft. ...	13.0	19.0
20.0	„	„	40 ft. ...	28.0	20.0


ic (Typhoid) Fever,
Weekly Rain-fall in inches.
Mean Weekly Temperature.
NO OF CASES.
Weeks Ending.
September.
October.
November.
December.


Weekly Rain-fall in Inches.
Mean Weekly Temperature.
0.66 0.61 0.28 0.16 0.48 0.04 0.09 0.17 0.24 0.21 1.17 0.68 0.52 0.02 0.89
37.2 56.8 49.1 49.7 52.9 48.8 45.8 48.4 47.0 41.9 38.8 39.6 42.9 35.4 43.9
NO. OF CASES.
Weeks Ending.
9 9 16 23 30 6 13 20 27 4 11 18 25 1
October. November. December Jan. 1898

Three Year Average: 16.3 *per cent. within* 20 *ft.*, 22.6 *per cent. within* 40 *ft.*

The remainder were over 40 ft. These measurements were taken because a stench from a grating or gulley had been so constantly charged by people near with occasioning typhoid; my own belief is that pollution of the neighbouring air with sewer gas lowers the resisting powers of the body, and thus causes those exposed to so deleterious an influence to fall more easily a victim of disease. I am of opinion that the emanations from collections of excrement in "bins" and pail closets, and from heaps of decaying refuse, act in the like manner as powerful predisposers of disease.

(*l*) Occupation of the Householders (in 1897):—

179 dwellings were affected; 39 of these were occupied by ordinary labourers, 30 by shoemakers, 8 by persons following no definite occupation, classifying themselves as gentlefolk; 7 (each) by carmen and carpenters, 6 by starch-workers, 5 by shopmen, 4 (each) by mustard-workers and painters, 3 by brewery-men, wood-choppers, bricklayers, sewerage labourers, tinmen and printers; 2 (each) by milliners, gardeners, publicans, builders. fish-hawkers, stone-dressers, and horse-hair weavers; 1 (each) by a corporation labourer, a tobacconist, an ironworker, a hair-dresser, a coffee-shop keeper, a shoe-factory manager, an accountant, a photographer, a cab proprietor, a coal porter, a hawker, a sawyer, an engine-fitter, a ticket collector, a fishmonger, a shopkeeper, a drover, a bailiff, a railway clerk, a platelayer, a tailor's purser, a domestic servant, a tailor, charwoman, a paper-bag maker, a yeast merchant, a coal-heaver, a railway labourer, a railway guard, a waiter, a clerk, an engineer, a scavenger, a pavior, a plumber, a traveller, a basket-maker, and a police constable.

(*m*) *Secondary Cases*:—

In thirty-one dwellings more than one member of the household contracted the disease; in fact, in these dwellings no less than forty-six cases occurred. In addition to these, nine cases were notified in public institutions: five in the workhouse, and four in the barracks.

SEASONAL VARIATIONS IN AGE-DISTRIBUTION AND FATALITY.

By SHIRLEY F. MURPHY.

In my Annual Reports to the London County Council I have published the results of an examination of the notified cases of scarlet fever and diphtheria in London, and which have led me to the conclusion that in these diseases there is seasonal variation both in fatality and age distribution. In the following Tables I give the results obtained from the use of the cases notified in the period 1892-7.

Seasonal Variations in Age-Distribution.

The following Tables show the number of cases of scarlet fever and diphtheria at several ages notified in each month

Scarlet Fever, 1892-7.

Month.	Notified Cases,* 1892-7.										
	All Ages.	0—	1—	2—	3—	4—	Under 5	5—	10—	15—	20 and Upwds.
January ..	8,976	152	372	623	805	861	2813	3502	1543	512	606
February ..	7,196	102	297	469	606	747	2221	2801	1222	425	527
March	7,842	114	337	544	719	741	2455	2946	1379	491	571
April	8,122	133	331	541	705	787	2497	3064	1428	503	630
May	10,377	160	411	717	918	973	3179	3912	1871	653	762
June	12,018	202	462	806	1075	1114	3659	4777	2035	745	802
July	14,987	220	534	965	1267	1423	4409	5884	2779	913	1002
August	14,513	252	632	1082	1315	1354	4635	5311	2570	1015	982
September ..	18,148	272	625	1076	1579	1697	5249	7646	3281	978	994
October ..	18,825	304	672	1213	1639	1738	5566	7726	3383	1055	1095
November ..	15,756	291	597	1016	1380	1471	4755	6222	2823	960	996
December ..	10,883	196	428	736	1015	1065	3440	4192	1858	609	784
Month.	"All Ages" taken as 1000.										
January ..	1,000	17	41	69	90	96	313	390	172	57	68
February ..	1,000	14	41	65	84	104	308	390	170	59	73
March	1,000	15	43	69	92	94	313	376	176	62	73
April	1,000	16	41	67	87	97	308	377	176	62	77
May	1,000	15	40	69	88	94	306	377	180	63	74
June	1,000	17	38	67	90	93	305	398	169	62	66
July	1,000	15	36	64	84	95	294	393	185	61	67
August ..	1,000	17	44	74	91	93	319	366	177	70	68
September ..	1,000	15	34	59	87	94	289	421	181	54	55
October ..	1,000	16	36	64	87	92	295	411	180	56	58
November ..	1,000	18	38	65	88	93	302	395	179	61	63
December ..	1,000	18	39	68	93	98	316	385	171	56	72

* Excluding cases in which no age is stated on the notification certificate.

Diphtheria, 1892-7.

MONTH.	NOTIFIED CASES,* 1892-7.										
	All Ages.	0—	1—	2—	3—	4—	Under 5	5—	10 -	15—	20 and Upwds.
January ..	5176	156	371	462	563	503	2055	1513	541	302	765
February ..	4301	122	314	396	447	438	1717	1272	465	226	621
March	4743	137	364	412	494	515	1922	1411	509	234	667
April	4401	130	311	378	490	482	1791	1258	437	245	670
May	5366	137	388	459	553	522	2059	1542	612	345	808
June	5666	110	363	469	547	571	2060	1659	664	369	914
July .. .	6474	139	363	459	599	624	2184	1922	827	459	1082
August ..	5748	148	342	481	570	483	2024	1412	704	485	1123
September ..	7180	136	368	496	648	667	2315	2178	898	553	1236
October .	7726	176	445	566	697	715	2599	2304	965	508	1350
November ..	7050	158	444	563	712	688	2565	2120	776	455	1134
December ..	6350	152	398	566	691	619	2426	1920	728	377	899
MONTH.	"ALL AGES" TAKEN AS 1000.										
January ..	1000	30	72	89	109	97	397	292	105	58	148
February ..	1000	28	73	92	104	102	399	296	108	53	144
March	1000	29	77	87	104	109	406	298	107	49	140
April	1000	30	71	86	111	109	407	286	99	56	152
May ..	1000	26	72	86	103	97	384	287	114	64	151
June	1000	19	64	83	97	101	364	293	117	65	161
July	1000	21	56	71	93	96	337	297	128	71	167
August ..	1000	26	59	84	99	84	352	246	123	84	195
September ..	1000	19	51	69	90	93	322	304	125	77	172
October	1000	23	58	73	90	92	336	298	125	66	175
November ..	1000	22	63	80	101	98	364	301	110	64	161
December ..	1000	24	63	89	109	97	382	302	115	59	142

of the period 1892-7, and the proportion at each age in every 1,000 cases at all ages. Although the cases are referred to calendar months, each month includes the cases of four or five complete weeks.

Study of these Tables shows that, in the case of scarlet fever, children under five years of age constitute a larger proportion of the total number of cases notified at the beginning and end of the year than in the middle; and that generally there is a steady decrease in this proportion from the beginning of the year until September is reached, when the proportion increases until the end of the year is reached. There is a slight exception to this rule in the month of March, and a more notable exception in the month of August. The meaning of the exception in March can only be determined by the aid of the figures of future years, but the greater irregularity in the month of August is no doubt attributable to the fact that schools are closed at this time, causing a reduction in the number of cases at school age, and a relative increase in the number of cases among younger children. Apart from these exceptions, there is a well-defined seasonal curve.

* Excluding cases in which no age is stated on the notification certificate.

The figures relating to diphtheria teach much the same lesson; but there is suggestion that the maximum proportion of children under five years of age may not eventually be found at the beginning of the year, but a month or two later. The figures of future years are required to determine this. The diphtheria figures show also the effect of the August holiday on the age distribution of the disease.

Seasonal Variation in Fatality.

In a Presidential Address to the Society in 1894, I stated that the London notification and mortality figures relating to scarlet fever and diphtheria gave evidence of a seasonal wave of fatality. In the following Tables will be found fatality rates calculated on the number of cases of those diseases notified in the several months of the period 1892-97, and the number of deaths registered in months beginning and ending one week later, the object being to associate as far as possible the deaths to the cases to which they belong.

After what has been said as to seasonal variation in age distribution, it is obvious that, *cæteris paribus*, there would be differences in the fatality due to this cause. In my Annual Report to the London County Council for the year 1895, I published Tables, making for the period 1892-95 corrections for differences in the age and sex distribution of the cases notified in the several months; and it was then found that these differences were insufficient explanation of the variations in fatality of that disease.

In the following Tables will be found the rates of scarlet

Scarlet Fever, 1892-7.

Month.	Cases.	Deaths.	Case-Mortality per cent.	Mean Case-Mortality taken as 100.
January	9,177	496	5.40	130
February	7,366	373	5.06	122
March	8,000	428	5.35	129
April	8,280	410	4.95	119
May...	10,589	466	4.40	106
June	12,265	521	4.25	102
July	15,309	582	3.80	91
August	14,850	622	4.19	101
September	18,523	586	3.16	76
October	19,178	586	3.06	74
November	16,057	652	4.06	98
December	11,092	542	4.89	118

Scarlet Fever, 1892-5.

	Case-Mortality calculated from Notified Cases and Registered Deaths.	Case-Mortality corrected for Differences in Age and Sex Distribution.
January	5.81	5.61
February	5.47	5.54
March	5.58	5.45
April	5.66	5.82
May	4.65	4.58
June	4.49	4.46
July	4.19	4.29
August	4.65	4.49
September	3.32	3.46
October	3.34	3.39
November	4.09	4.11
December	5.43	5.28

Diphtheria, 1892-7.

Month.	Cases.	Deaths.	Case-Mortality per cent.	Mean Case-Mortality taken as 100.
January	5678	1322	23.28	111
February	4856	1104	22.73	108
March	5271	1173	22.25	106
April	4997	1082	21.65	103
May	5821	1212	20.82	99
June	6103	1208	19.79	94
July	7086	1356	19.14	91
August	6253	1282	20.50	98
September	7967	1545	19.39	92
October	8453	1685	19.93	95
November	7762	1638	21.10	101
December	7111	1626	22.87	109

fever and diphtheria fatality in the several months of the period 1892-97. The scarlet fever rates obtained by use of the figures of the period 1892-95, before and after correction for differences in age and sex distribution, are also given.

The Tables relating to the period 1892-97 show generally a decrease in fatality from the beginning of the year until September is reached, and then an increase to the end of the year. There is a slight exception to this rule in the case of scarlet fever in March, which is interesting on account of what has been said as to the larger proportion of cases under five years of age notified in that month; and a considerable exception in the case of scarlet fever and diphtheria in the month of August, obviously due to the effect of the holiday. Apart from these exceptions, the fatality curve is strikingly regular in both diseases.

THE JENNER MEMORIAL MEDAL.

In the last volume of the *Transactions* the circumstances which led to the founding of this Medal were detailed, and a hope was expressed that in the present volume it would be possible to furnish a description of the Medal and a facsimile of the design.

The engraving on the opposite page is from blocks prepared by Mr. Allan Wyon, F.S.A., who designed and executed the Medal, and the subjoined bye-laws governing the award of the Medal have been drawn up by the Council. At the Annual Dinner of the Society, which was held on Friday, June 24th, 1898, the President announced that the first Jenner Medal had been awarded to Mr. William Henry Power, F.R.S.

Bye-Laws as to the "Jenner Medal."

2. The medal, which shall be struck in bronze, shall be known as the "Jenner Medal," and shall be awarded for distinguished work in Epidemiological research.

2. The medal shall be awarded when, and at such times as, the Council may determine.

3. The award of the medal shall not be restricted to British subjects.

4. The bestowal of the medal shall be vested in the Council on the recommendation of a sub-committee consisting of the President, the Treasurer, and the Honorary Secretaries for the time being of the Society, together with not more than three other members of the Council who shall be elected by the Council. The recommendation of the sub-committee shall be confirmed by the Council.

5. At least ten days' notice shall be given of the Council meeting at which the election of the Council's representatives to the Medal sub-committee is to take place, and the fact of such election shall be stated in the notices announcing the meeting.

The medal shall present on the obverse a three-quarter face of Edward Jenner, together with the inscription, "Edward Jenner, M.D., F.R.S., born 1749, died 1823," and on the reverse a representation of the Earth such as is engraved on the diplomas of the Society, surrounded by the following inscription: "Centenary of Vaccination Celebrated 1896. For work of Great Merit. Epidemiological Society of London. *Venienti Occurrite Morbo.*"

The name of the Medallist, in his native language, together with the date of the award, shall be inscribed on the rim of the medal.

THE JENNER MEMORIAL MEDAL.

OBITUARY.

SURGEON-GENERAL JOHN MURRAY, M.D.,

Ex-President of the Society.

SURGEON-GENERAL JOHN MURRAY, M.D., who died at his residence, Sherringham, Norfolk, on July 27th, aged 88, had been for many years a member of this Society. He entered the H.E.I. Co.'s service in 1832, having graduated in Edinburgh in 1826. His graduation essay was on the formation and solution of urinary calculi. Thus early he took up the study of a special subject, which was of great use to him in his subsequent career, and he attained considerable celebrity, when Civil Surgeon of Agra, as a lithotomist. But this was not the only branch in which he excelled ; for, in general surgery, he was well known to be a bold and skilful operator. When a young man, he profited by the experience of an uncle, who was also a distinguished medical officer ; and, building his own practice upon the foundation his uncle had laid, he rapidly rose to eminence in India.

He served with the Horse Artillery till 1842, and for two years was in charge of the convalescent depôt at Landour. He was Field Surgeon with the army of the Sutlej in 1846, and was at the battle of Aliwal, for which he received a medal, and was honourably mentioned in despatches Afterwards he became Residency Surgeon at Indore, and in 1848 Civil Surgeon at Agra. In 1858 he was promoted to the rank of Deputy Inspector-General of Hospitals, and to that of Inspector-General in 1865 ; finally, he was appointed head of the Medical Department of Bengal, from which he eventually retired in 1871.

His principal literary work was *The Pathology and Treatment of Cholera*, which ran through two editions, one published in 1874 and the second in 1884, but he also wrote on many other kindred subjects.

He took an active interest in the improvement of military barracks in India, which contributed much to the health and comfort of the soldiers. He originated the plan of moving regiments out into camp when attacked with cholera, a proceeding which has proved of inestimable value in combating that disease.

After his retirement he gave up practice, and devoted himself mainly to the study of the reports on cholera published by the Indian Government; and the results of his labours were regularly communicated to the Epidemiological Society, of which he held the office first of President and afterwards of Vice-President, and at the meetings of which, till quite lately, he was an effective debater.

Dr. Murray was a firm believer in the propagation of cholera by human agency, a view which he acquired by close observation of the spread of epidemics in the East, and one which he must have been rejoiced to see so fully confirmed by the more recent investigations of bacteriologists. He was a man of continual diligence and of indefatigable perseverance. He held very strong opinions, and never hesitated to express them, which perhaps may to some extent account for his never having received any decoration. However this may be, his professional brethren are able to testify that few men have succeeded in doing more useful work in India than John Murray.

FREDERICK WILLIAM BARRY, M.D., D.SC.

DR. BARRY'S sudden and untimely death, the result of accident, occurred on October 12th, 1897. At that date he had been fifteen years Inspector, and latterly had been senior inspector, of the medical department of the Local Government Board. Previously he had held the post of Sanitary Commissioner with the Government of Cyprus, and had been Medical Officer of Health for the combined Craven district in his native county of Yorkshire. His career at Edinburgh University (where he graduated M.D. in 1876) had been one of particular distinction. Quite early, Barry decided to make for himself a future in public health work; and thereafter, throughout the whole of his short working life—he was only forty-six—he persistently kept in view the obligations and duties which his choice had imposed on him: always he was quietly preparing himself to deal with any problem or to perform any duty which in the future might need to be undertaken. It was in this spirit that, in 1884, he obtained his D.Sc. degree in public health at Edinburgh, and some years later was called to the Bar as a member of the Inner Temple; and with the same object he collected together his exclusive and valuable library of public-health literature.

Thus armed with knowledge in all branches of his work, possessed of much ability, and above all of high character, Barry always came to a fresh undertaking with a large, often little suspected, fund of strength in reserve. Hence it was that the bigger and the more intricate the inquiry on which he was engaged, the more ready Barry to reduce matters to order, and the greater the ease with which he seemed to overcome difficulties. Indication of this faculty can be seen in every one of his official reports, in which the reader cannot fail to be struck by his masterly arrangement of subject, by his method of setting out facts, and by the logic of his conclusions. It is characteristic of these reports that, while chary of hypothesis and explanation, Barry was never content until he had obtained every fact relating to the matter in hand, nor until, when he had collected his facts, he had set them out in just proportion from every conceivable viewpoint.

The report by which Barry has perhaps been best known was that upon epidemic small-pox in Sheffield in 1887-8.

This report, comprising some 300 folio pages of facts and statistics, was an exhaustive account, such as had never before appeared, of the behaviour of small-pox in present times among a large community dependant for their protection upon the infantile vaccination enforced by the English law. Barry let the facts of the relation between small-pox and vaccination in Sheffield tell their own tale: district by district, street by street, ages by ages: the whole furnishing demonstration of the nature and extent of the protection which had been afforded, and a lesson to any who cared to understand it of the paramount importance to the State of an efficient vaccination system. This report, prefaced by a powerful introduction by the late Sir George Buchanan, was published in 1889. But its teaching was lost upon the Government. The same year, Mr. Ritchie, then President of the Local Government Board, put political convenience before public welfare, and by appointing the Vaccination Commission virtually abandoned the system of compulsory vaccination in the country. From time to time, during the seven years' session of that Commission, Barry was engaged in putting the Sheffield evidence before them, and in confuting the many attacks which had been made on his report. And in the end the Commissioners recorded their conclusion that the material correctness of Barry's facts was unshaken, and they drew upon them largely in their final pronouncement.

Noteworthy among other official reports was Barry's inquiry, made in conjunction with Mr. Gordon Smith, into back-to-back houses, and his investigations into epidemic enteric fever among the several large populations in the Tees valley in the years 1890 and 1891. The report upon the latter inquiry furnished a classical case of a considerable river carrying enteric fever infection for long distances, and distributing fever far and wide among populations dependant upon it for their water-supply.

Barry's force of character, his earnestness and his unselfishness, could not fail to impress themselves on those who worked with him. Largely for this reason, partly also owing to his Yorkshire directness of speech and habit of going straight to the point, his success was nowhere greater than in organisation and administration. Two in particular of his administrative acts may be referred to. During his two years' tenure of office as Sanitary Commissioner of Cyprus he organised and carried through the first census taken in that island a census comprehending dwellings, population, conjugal

state, age, religion, and infirmities of a widely-scattered population of many nationalities. For his report on this census, published as a Parliamentary paper in 1884, Dr. Barry received special acknowledgement from the Colonial Office. The other instance is the Port and Riparian Sanitary Survey made by inspectors of the Local Government Board in 1893-94. This survey was made primarily to secure proper provision at all English and Welsh ports against imported cholera: in practice it did much more, and has had lasting results in improved efficiency of administration among sanitary districts along the coast-line. The direction of the undertaking, and also of a similar survey of certain inland districts, was almost entirely in Barry's hands. No more important piece of work had ever before been undertaken by the medical department of the Local Government Board. Only those who worked with Barry at that time can tell how much he was responsible for its success; and none can estimate better than they the extent of the loss which the death of their senior colleague and future chief has inflicted alike upon the civil service and the public health service of the country.

The Ordinary Meetings of the Society are held at

11, CHANDOS STREET, CAVENDISH SQUARE,

ON THE THIRD FRIDAY OF EACH MONTH FROM NOVEMBER TO MAY INCLUSIVE, UNLESS OTHERWISE ANNOUNCED.

THE CHAIR IS TAKEN AT HALF-PAST EIGHT O'CLOCK P.M. PRECISELY.

Subscriptions may be paid to the Treasurer. The Annual Subscription of Ordinary Members is One Guinea.

Ordinary Members are entitled to all privileges of membership, and to receive a copy of all the Society's publications issued during the year for which their subscriptions are paid. But Ordinary Members, resident beyond the limits of the Metropolitan Postal District, and having paid one or more annual subscriptions, may, on expressing to the Hon. Treasurer a wish to that effect, be distinguished as Non-Resident Members.

Non-Resident Members are liable to an annual payment of half-a-guinea. They have the privilege of attending meetings, and are entitled to receive the publications of the Society issued during the year for which their subscription is paid; but they are not entitled to vote at meetings of the Society nor to hold office in it.

The Rules and Regulations, etc., of the Society, with an Exposition of its Objects, may be obtained from the Secretaries.

The Transactions for the Sessions 1859-60, 1866-67, *and* 1867-68 *are out of print. With these exceptions, those for the Sessions from* 1860-61 *to the last Session inclusive, may be obtained from the publishers,* Messrs. Shaw and Sons, Fetter Lane, E.C. *Prior to* 1859-60, *the Transactions were published in the* "Sanitary Review." *The issue of a New Series of the Transactions was begun in* 1882.

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